STREET FOODS IN DEVELOPING COUNTRIES: THE POTENTIAL FOR MICRONUTRIENT FORTIFICATION

by

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ACRONYMS

ACC/SCN	UN Administrative Committee on Coordination/Subcommittee on Nutrition
BP	British Pharmacopoeia
BPC	British Pharmaceutical Codex
DAB	Deutsches Arzneibuch 7
EDTA	Ethylene Diamine Tetraacetic Acid
EPOC	Equity Policy Center
FAO	Food and Agriculture Organization
FCC	Food Chemical Codex
HACCP	Hazard Analysis Critical Control Point
IDRC	International Development Research Center (Canada)
ILSI	International Life Sciences Institute
IPB	Food Technology Development Center (Bogor Agricultural University, Indonesia)
JECFA	Joint Expert Committee on Food Additives
MI	Merck Index
MSG	Monosodium glutamate
NF	National Formulary (U.S.)
PAHO	Pan American Health Organization
Ph. Eur.	European Pharmacopoeia
TNO	Tropical Health Organization (Bureau for International Coordination and Consultancy, Delft, the Netherlands)
UK	United Kingdom
US	United States
USAID	United States Agency for International Development
USP	United States Pharmacopoeia
VU	Free University (Center for Development Cooperation Services), Amsterdam, the Netherlands
WHO	World Health Organization

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SUMMARY

The street food trade is a growing sector in many developing countries today. Its expansion is linked with urbanization and the need of urban populations for both employment and food. Despite this, the role of street foods in supplying the nutrient needs of urban populations has received little official attention and more notice has been paid to the potential dangers arising from the consumption of street foods than to any benefits they might offer. Much of the bias against street foods, however, is unfounded and based more on prejudice than empirical data.

Official data on the street food trade and the consumption of street foods are largely lacking, but a number of studies have been conducted which show that the street food trade is a large and complex sector, which provides a means of livelihood and an affordable source of food to many millions of people. The potential of street foods for improving the food security and nutritional status of urban populations remains almost totally unexplored.

There are a number of aspects of street foods which make them promising vehicles for micronutrient fortification. The data available on the consumption of street foods show that they are inexpensive and available foods, which in many countries form an integral part of the diet, and that they are consumed with regularity and consistency across all income groups, but particularly by the urban poor and, in some countries, children. Street foods are extremely diverse both in terms of what is available (they encompass drinks, meals, and snacks) and the ingredients from which they are made. The ways in which street foods are processed are also extremely variable and range from the preparation of foods "on the street" in relatively heterogeneous and unregulated conditions to the central processing of ready-to-eat foods, such as snacks, that although manufactured by the formal sector food industry, are distributed and retailed via street food vendors. This implies two potential strategies for fortification: (1) ingredient-based fortification of universal ingredients, which have passed through some form of centralized processing; and (2) food-based fortification of centrally processed foods.

Potential constraints to fortification include food safety requirements (both quality control of the fortification process and microbiological safety), consumption requirements, cost, and the enormous variability of street foods in terms of ingredients and the ways in which they are processed. Information is needed on all of these to evaluate the potential for the fortification of street foods and to identify suitable vehicles in specific country contexts.

INTRODUCTION

Aims

This report reviews information on the availability, cost, and consumption of street and snack foods in developing countries and assesses the potential for fortifying these foods with micronutrients as a means of preventing and controlling micronutrient deficiencies. Related issues, such as the safety of street foods and their production and sale as a business activity for women, will also be considered. This report is targeted primarily to scientists--including food scientists--who are working on bridging the gap between the formal and informal private sectors as well as the public health and agriculture sectors; and secondarily to operational researchers working to fill some of the voids. This review is not intended to be a technical manual, but rather a discussion of program issues relating to the potential for the micronutrient fortification of street foods.

Rationale

Street foods have recently begun to attract the attention of governments and various international agencies because one of the features of urbanization in developing countries has been a proliferation of the street food trade (FAO 1989). Street food vendors are a ubiquitous and conspicuous presence in most cities and they sell a variety of wares ranging from snacks and drinks to full meals. An increase in the consumption of street foods is one of the dietary trends that has been identified as characterizing urban diets (Rossi-Espaguat et al. 1991; Hussain 1990; Lunven 1994).

Despite this, the attitude of many governments towards the street food trade has been indifference with little or no interest in the role that it may play in either the economy or the food supply of the city. The rise in consumption of street foods has been identified by some as a deleterious trend (Gopalan 1992), but this bias against street foods and also the street food trade is largely unfounded. According to Tinker (1988), the neglect of street foods stems in large part from a series of misconceptions about both the nature of the street food trade and street foods themselves:

- that the street food trade is a marginal and transitory economic activity, which is a hangover from traditional market activities and which in time will disappear;
- that it is dominated by women;
- that it is focused in the main commercial areas of urban centers;
- that street foods are "dirty" and "dangerous" to eat;
- that only the poor eat them;
- that they do not make an important contribution to dietary intake.

As will be illustrated in the next section, the information currently available shows that the street food trade is large and complex, providing both an important means of income generation and an affordable source of food for many millions of people. The precise roles of street food vendors and street foods, however, are not well defined or understood and investigation of these should be an initial activity in any evaluation program.

Micronutrient deficiencies remain major public health problems in developing countries in both rural and urban contexts with deficiencies of vitamin A, iron, and iodine being the most prevalent (ACC/SCN 1992; Rossi-Espagnat et al. 1991). Various strategies have been formulated to prevent and control these deficiencies, of which fortification is considered to be one of the most cost-effective. Street foods have been identified as a means of reducing problems of urban food insecurity and as a possible vehicle for micronutrient fortification (Atkinson 1992; Barth 1983) but, as yet, their potential for fortification remains unexplored.

Dietary deficiencies remain the most serious nutrition problems in developing countries. Nevertheless, because of economic, demographic, lifestyle, and dietary changes, diet-related chronic diseases--such as cardiovascular disease, adult onset diabetes and certain cancers--are increasing in developing countries, particularly in urban areas (WHO 1990; ACC/SCN 1992). As a result, they are likely to demand more attention in relation to nutrition interventions. Although the balance of concern will vary from country to country, undernutrition among the poor in developing countries remains a main priority and any option to improve dietary quality should be explored (Gillespie and Mason 1991).

Definition of Terms

Street Foods

As already mentioned, street foods are an extremely heterogeneous food category, encompassing meals, drinks, and snacks. They also show great variation in terms of ingredients, methods of retail and processing, and consumption. Various attempts have been made to define them, but the most widely cited definition is that of FAO:

> "Street foods are ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers especially in streets and other similar public places" (FAO 1989).

The central characteristic of street foods in this definition is their retail location, that is "on the street." To differentiate street food vendors from formal sector food establishments, such as restaurants, the Equity Policy Center (EPOC) adds the further qualification that street foods are sold on the street from "pushcarts or baskets or balance poles, or from stalls or shops having fewer than four permanent walls" (Tinker 1987). In terms of production, street foods may be centrally processed foods made by the formal sector food industry, or they may be processed within the street food trade either by the

vendor her/himself or another small-scale processor.

Snacks

Snacks are a rather nebulous and diverse group of food items and the term here refers to foods that are consumed between main meals and so tend to be of a less substantial nature. Many street foods are snack items, which include commercially produced snacks retailed via street food vendors as well as items produced within the informal sector. For the purposes of this discussion, the term is taken to refer to food items, whether prepared on or off the street, and not beverages.

The Street Food Trade

The characteristics of the street food trade itself are important. Those who manufacture and/or sell street foods are small-scale operatives or micro-entrepreneurs who form a part of the so-called informal sector. This is distinct from the formal sector food industry in a number of ways, which will affect the potential for the micronutrient fortification of street foods. Because much of the rapidly increasing urban population in developing countries has not been absorbed into the formal organized labor market, it has taken up a range of self-employed, small-scale, income-generating activities, both legitimate and illegitimate, which form the informal sector (also sometimes called the tertiary sector or bazaar economy).

The activities comprising the informal sector are marked by a number of characteristics: ease of entry, reliance on indigenous resources, family/household ownership of the enterprise, small-scale operatives, high labor intensity, use of traditional technology and skills acquired outside the formal education system, and operating in unregulated and competitive markets (Hart 1973). This contrasts with the formal sector which is characterized by corporate rather than family or individual ownership, use of large-scale modern technology, capital investment, and regulated markets. The rise of the informal sector has been identified as a persisting and expanding feature of urban economies in many developing countries. There is debate over the nature and definition of the informal sector and its relationship with the formal sector. For a discussion of these issues and how they relate to the street food trade see Atkinson (1992), Bapat (1992) and Tinker (1987).

REVIEW OF AVAILABLE INFORMATION ON STREET FOODS IN DEVELOPING COUNTRIES

This section reviews the available data on street foods and snacks in developing countries. As mentioned earlier, street foods have received little official attention and the information currently available on them is somewhat patchy and inconsistent. Much of the data used in this section derive from two large studies - the Equity Policy Center's (EPOC) seven country Streetfood Project, and the Wholesomeness of the Common People's Food in Indonesia Project (more commonly called the Bogor Streetfood Project).

The first phase of the former was conducted in 1982 to 1984 in four countries, Senegal (Posner 1983), Bangladesh (Owens and Hussain 1984), Indonesia (Chapman 1984), and the Philippines (Barth 1983). The second phase was conducted in 1984 to 1986 in three countries, Nigeria (Kujore and Chase 1985; Pearce 1984), Egypt (Loza 1985), and Thailand (Szanton and Sirisambhand 1986). The USAID Office of Women in Development funded phase one and the Ford Foundation phase two. Although the focus of the EPOC studies was on the socio-economic aspects of the street food trade, particularly as they pertained to opportunities for income-generation by women, data were also collected on the consumption patterns of street foods. The Bogor Streetfood Project was conducted between 1988 and 1992 by the Food Technology Center of the Bogor Agricultural University and the Division for Nutrition and Food Research of TNO-Zeist in Bogor, a town in Western Java. This project comprised a series of related studies of the production, distribution, and consumption of street foods. Based on these studies, trial interventions were conducted to improve the safety of street foods and strengthen the socio-economic position of street food traders.

Apart from these two projects, there are only a handful of other studies in the literature which have examined the nutritional aspects of street foods (see appendix 1 for a listing of these). The food safety and regulatory aspects of street foods, on the other hand, have attracted attention from both governments and international organizations, such as FAO and WHO. In addition to other activities, FAO has run a series of regional workshops in Africa, Asia, Latin America, the Caribbean, and the Pacific, culminating in a global consultation in Indonesia in 1988 (FAO 1989). For a summary of FAO's activities see FAO (1989). WHO and PAHO have also been active in this area, the latter specifically in the Caribbean and South America (PAHO 1994). The International Life Sciences Institute (ILSI) has also organized several meetings (ILSI 1993), some in collaboration with other organizations including FAO and WHO. These include the first and second Asian food conferences held in 1990 and 1994 in which street foods featured, and also one meeting dedicated solely to street foods held in 1993 in Beijing, which was co-sponsored by the Chinese Academy of Prevention Medicine in cooperation with FAO and WHO (ILSI 1993).

Another omission in the information available on street foods and snacks is the lack of data on rural contexts. Although the rapid recent growth of the street food trade appears to be a principally urban phenomenon, street foods are also a common feature of rural markets, and rural populations are rising in many countries. The potential of using street foods as a means of targeting nutrition interventions at urban populations has been virtually unexplored.

The Street Food Trade

The Nature of the Street Food Trade and its Economic Importance

Like other informal sector enterprises, street food enterprises are characterized by the small scale of the operation, use of traditional food processing technologies, and low capital costs that allow ease of entry into the sector (Tinker and Fruge 1982). Those who participate in this sector are principally the urban poor and this has been seen by some as an innovative response or coping strategy on their part when denied access to more formal employment structures. As Atkinson (1992) points out, however, this view originated in the 1970s against a backdrop of economic expansion; the macro-economic context of the 1990s is very different and support of the informal sector should not be seen as a panacea for the urban poor.

Because of its very nature, the informal sector is not enumerated by official data-collecting agencies; thus official statistics on the street food trade are virtually non-existent. The EPOC and Bogor projects and various FAO studies, however, have shown that the street food trade generates a surprisingly large volume of business, which involves large amounts of money and also provides a competitive source of employment and income to millions of people. For instance, FAO estimates that there are approximately 100,000 vendors in Malaysia whose collective total annual sales amount to over $2 billion (Dawson and Canet 1991)! The EPOC studies found that the annual volume of trade ranged from $67 million in Bogor, a city of 250,000 people, to $2 million in Manikganj, a small provincial town of 38,000 people.

The trade also provides an important source of employment and income; EPOC found that the street food trade comprised from about 6 percent of the total labor force in Zinguinchor, Senegal and Manikganj, Bangladesh to 15 percent and 25 percent in Iloilo City, the Philippines, and Bogor, Indonesia, respectively (Cohen 1985). Although hard work with long hours, the income derived is generally above earnings from alternative sources of employment. The earnings of paid assistants, however, are often less. A study in Uganda found that most vendors earned a favorable wage--the majority earned more than the minimum government civil service wage (87 percent earned US $5-$20 per day) and none earned less than the minimum wage--but most assistants were paid less than US $9 per month (Nasinyama 1992).

Despite the need for further documentation, it can be seen that the street food trade makes substantial contributions to these urban economies (Cohen, 1985).

Street Food Enterprises

Most street food enterprises are single person or household-based. A study in Pune, India, for instance, found that most vendors owned only one kiosk/stall or cart (only 12 per cent owned two and very few more than two), and most received assistance, either from family members (45 percent), paid workers (8 percent) or both (19 percent) (Bapat 1992). Similarly, in Jamaica, 90 percent of vendors were single person enterprises and the remaining 10 percent were joint ventures (Powell et al. 1990). A similar situation was found in the EPOC and other studies; the one exception being a study of street food vendors in Nigeria which found that, in addition to assistance from family members, most vendors employed one or two paid assistants (FAO and Food Basket Foundation International 1991).

It is important to recognize that the street food trade is both a retail and a productive activity: although the sale of street foods is the most visible part of the trade, most street foods have been processed to some extent, much of which may have occurred unseen off-street. The EPOC studies found that 75 per cent of vendors in the Philippines, Indonesia, and Senegal and 42 per cent in Bangladesh had processed some or all of the foods that they sold (Tinker and Cohen 1986). Because of this, the trade should be seen as part of the whole food system, rather than just as a service or retail activity (Cohen 1985; Weber 1987). The extent to which foods are processed, and by whom, varies; some street food vendors also provide an outlet for foods processed by others in the informal sector, and also, in some countries, for small- and large-scale food processing industries in the formal sector (Barth 1983; Powell et al. 1990). More information on these aspects of street foods is currently lacking, but, as discussed further in the next section, it is vital to assess their suitability for fortification in specific contexts.

Acquisition of Ingredients

Complex linkages exist between vendors and the suppliers of ingredients and ready-made foods. The EPOC study in Iloilo City in the Philippines found that the networks through which vendors purchased their raw materials and other items for resale were complex and extended into nearby agricultural districts and as far afield as Manila (Barth 1983). Pre-prepared products were purchased from small local companies, households, and large, commercial food processors in Manila. Some vendors bought their materials directly from a variety of suppliers, which included local markets and groceries, but others purchased them indirectly via suppliers who acted as retail intermediaries. A study of the food supply system in Mexico City found some family-based enterprises controlling all the steps in the food chain from growing/rearing the raw ingredients in villages outside the city, to processing, distributing, and selling the food (Bueno 1988). In other cities, such as Ibadan,

Nigeria, local markets were the main sources for ingredients which were purchased on a daily basis (Akinyele 1987). The information available shows that patterns of acquisition of ingredients are intricate and variable.

Rural-urban linkages were found in other locations, with the urban street food trade providing an outlet for the products of rural-agro processing (Tinker and Cohen 1986). In Bangladesh, where the overt participation of women was very low, many street food vendors acted as retailers only (57 percent), selling snacks and foods made by village women (Owens and Hussain 1984). The distribution channels were complex; few women producers sold direct to the street food vendors, but instead used a middleman. Unfortunately, there is virtually no available information on those involved in activities other than selling street foods, such as the supply and processing of materials. Again, the means by which vendors acquire ingredients and from whom is an area which would require investigation in any program evaluation because it would have a direct impact on the potential for the fortification of street foods.

Street Food Vendors

Many studies have examined the characteristics of vendors and have found that street food vendors do not form a homogenous group, but differ according to various socio-economic and demographic criteria and, in some locations, fall into identifiable groupings.

In terms of mode of selling, vendors can be broadly classified into stationary and ambulatory. EPOC found that stationary vendors, who sold their wares from small stalls, kiosks, pushcarts, and so forth, were the predominant type in most of the countries they studied (Powell et al. 1990). Most vendors operate from selected strategic locations, including bus and train stations, markets and shopping areas, commercial districts, outside schools and hospitals, residential suburbs, factories, and construction sites. In some places, it appears that vendors have a regular clientele (Nasinyama 1992), and in Mexico City it was found that vendors charged lower prices to regular customers (Bueno 1988). A common perception is that street food vendors tend to concentrate in downtown commercial areas, but the EPOC studies found that this was the exception in all locations except Manikganj, Bangladesh and Chonburi, Thailand (Tinker 1987). In Nigeria, 23 percent of vendors were located in residential areas (FAO and Food Basket Foundation International 1991).

EPOC found that totally ambulatory vendors who sell their wares from mobile carts, baskets, trays, and balance poles were in the minority in all locations studied (Tinker 1987). Even those who sold foods from baskets or trays tended to occupy the same spot every day. Truly mobile vendors only constituted approximately 25 percent of vendors in Ife, Nigeria, 18 percent in Chonburi, Thailand, and 10 percent in Ziguinchor, Senegal (Tinker 1987). Some of these followed fixed routes.

The socio-economic and demographic characteristics of street food vendors may vary along with the extent and type of organization of sub-sectors within the trade. The Bogor Streetfood Project provides detailed baseline studies of entrepreneurs involved in the street food trade, their socio-economic characteristics, their enterprises, the practical problems and constraints that they faced, how these affected the quality of their wares, and their interest in the proposed interventions.

The Bogor Studies

The following discussion draws on the findings of one of the baseline studies (TNO et al. 1992a). This study clearly demonstrates the complexity of the street food sector: It does not constitute a homogenous group, but rather is composed of various groups who have no centralized organization or regulatory mechanisms and who differ in terms of internal social organization and the extent to which they participate in the wider social environment. In exploring the receptivity and potential of the different sectors within the street food trade in Bogor, the study focused on those entrepreneurs who were involved in productive processes because they control the purchase, preparation, storage, and sale of foods and thus would be the appropriate agents through whom to introduce food-based interventions.

The study identified entrepreneurs in three categories:

- *Entrepreneurs with stationary outlets in strategic locations* (17 percent of all): these were predominantly men (68 percent), although women were involved in the preparation of foods; many were migrants (57 percent); the enterprises of these entrepreneurs tended to be larger and more capital intensive; and many employed two to four workers. Strategic locations were schools, offices, bus stations, and shopping centers.

- *Entrepreneurs with stationary outlets in residential areas* (48 percent of all): these were mainly women (77 percent). Most were born in Bogor; and most ran small household-based enterprises which were combined with other responsibilities, such as child care.

- *Entrepreneurs with an ambulatory distribution system* (35 percent of all): these were predominantly men (72 percent) and migrants to the city (72 percent). Most were lone operators (67 percent), either self-employed or working for employers who provided a range of facilities, such as the rental of a pushcart.

Participation in government-run organizations, such as health care centers, was low, but was high in informal locally run institutions, such as Koran reading clubs and savings clubs, especially among the women entrepreneurs based in the villages. Migrant entrepreneurs participated significantly less, but tended to form social clusters with each

other, often on the basis of shared accommodation in the village. Many migrants also maintained links with their village of origin and returned home regularly for religious festivals, other important events, and agricultural activities. The entrepreneurs operating in strategic locations also showed social cohesion and cooperation based largely on the physical nearness of their enterprises.

The interest of entrepreneurs in the proposed interventions varied; the younger and more educated showed more interest, but there was no difference in relation to the size of their enterprise or migrancy status. Men showed more enthusiasm than women. The women's apparent indifference was ascribed to their lack of time and the demands of other responsibilities, and also their tendency to discount the importance of their enterprises and their own eligibility. Lack of capital was the most commonly cited problem by both men and women. Few entrepreneurs had access to formal credit facilities and most borrowed money from a variety of sources, such as relatives, colleagues, and money lenders. Other problems that the vendors faced were lack of business skills, lack of access to collective facilities such as water taps and waste disposal systems, and lack of recognition by local planning administrations. Feelings of insecurity and vulnerability made few interested in investing in their businesses.

These studies point to the clear need to understand the social organization of the street food trade as a whole and its sub-sectors in specific contexts because these affect the accessibility and interest of street food vendors to interventions. The trial interventions conducted as part of the Bogor Streetfood Project are discussed later in this section.

The Participation of Women

The overall participation of women in the street food trade is high, but the degree and type of involvement varies according to country context. The EPOC studies found that in the Philippines and Senegal, women vendors predominated, representing 63 percent and 53 percent of vendors respectively. Other studies in Africa (Uganda, Kenya, and Nigeria) have also found a predominance of women vendors (over 60 percent in all countries) (FAO and Food Basket Foundation International 1991; Korir 1994; Nasinyama 1992). FAO studies have also found a high level of participation of women in some South American countries; in Colombia, 59 percent of vendors were women, and, in Peru, 64 percent (FAO 1989). In Indonesia and Bangladesh, however, both Islamic countries, women constituted only 16 percent and 1 percent of vendors, respectively (Cohen 1985). In Nepal, also, women vendors were in the minority (28 percent) (Joshi et al. 1988). These latter figures, however, obscure the less visible involvement of women in processing and preparing foods prior to sale; about 25 percent of the vendors in both Indonesia and Bangladesh reported that their wives assisted in preparing foods for sale. Women outside the household were also involved as paid assistants to process and prepare foods; 12 percent of male vendors in Manikganj employed female assistants. In both Indonesia and Bangladesh, many of the traditional sweets and snacks sold were made by women, individually or working in groups, and sometimes based in rural areas.

A study in Pune, India, found a similar situation: Only 13 percent of vendors were women, but most male vendors had assistance from either family members or paid workers of which 58 percent were women (Bapat 1992). Children were also employed, especially girls. In contrast, most of the women vendors in Pune were single-person operatives receiving no assistance. In Nigeria, EPOC found that women were involved as producers and trading intermediaries between rural and urban areas (EPOC 1984). This may be an extension of traditional income-generating activities for rural women, which include food processing and crop sales (Cohen 1985).

The street food trade is an important income-generating activity for women in both urban and rural contexts, which is compatible with additional responsibilities such as child care. Because of the ease of entry into the trade and its use of traditional skills and equipment, EPOC identified the street food trade as playing an important role in women's strategies for self-sufficiency (Cohen 1985). According to FAO, the participation of women in both the preparation and marketing of street foods is increasing in many countries (FAO 1989). Interventions in the street food trade could thus provide an opportunity to target women and link income-generating projects with nutrition-relevant actions, such as fortification. The Bogor studies illustrate the need to understand the circumstances in which women entrepreneurs operate and the other activities which they may combine with running their business.

Street Foods

Diversity

The diversity of street foods is extensive, as they vary widely not only from country to country, but also from vendor to vendor. Street food ingredients are country specific and mostly undocumented. There are so many varieties that it is impossible to provide a menu of all the different street foods consumed around the world. The EPOC studies found a vast range available in each location studied; a list of popular street foods in Bogor alone contains nearly 300 items in total, including numerous varieties of rice-based meals, fried snacks, traditional cakes, soups and porridges, drinks, and fruit (Chapman 1984). The ingredients and means of preparation were equally diverse and included meat, poultry, fish, seafood, eggs, cereal products, soya products, fruit, and vegetables. They were fried, roasted, boiled, baked, steamed, or eaten raw. Street foods can be grouped in various ways: by meal (meals, constituents of meals, snacks, and drinks), by number and type of ingredients (simple and complex foods that contain more than one main ingredient), and by level and type of processing (minimally processed foods, such as fruit which may only have been peeled or sliced, traditionally processed foods made by the vendor or another informal sector operative, and centrally processed commercial foods). Although traditional foods form the bulk of items sold, foods processed by larger-scale food manufacturers are an important category of foods sold in some contexts (Powell et al. 1990; EPOC 1985).

The range of foods sold by vendors in specific contexts varies. The EPOC studies and other studies in Jamaica and Pune, India found that in most countries vendors sell more than one kind of product, although many specialize in certain food types or product lines, such as rice- or noodle-based dishes (Bapat 1992; Cohen 1985; Powell et al. 1990). Specialization in single product lines was practiced only by a minority of vendors, except in Senegal where there was some specialization by men and women in product lines (Posner 1983). This gender specialization was not so pronounced in other countries, although in Indonesia there was a trend for men to specialize in wheat-based noodle dishes and women in rice dishes (EPOC 1985). In the EPOC studies, and in Jamaica and India, it was found that the preparation and sale of traditional foods tended to be the preserve of women (Bapat 1992; Cohen 1985; Powell et al. 1990).

Cost and Availability

One of the common prejudices held against street foods is that they are less nutritious and more costly than foods prepared at home. Although little quantitative information is currently available on these aspects of street foods, the findings of the EPOC and other studies do not support these assumptions.

The cost of street foods is usually competitive compared with that of foods purchased from larger food establishments, such as restaurants and fast food outlets. Also, due to the sometimes high costs of fuel and ingredients in urban contexts, economies of scale can create a street food cheaper than the same food prepared at home (FAO 1989). Broader economic factors can also affect the cost of street foods relative to home-prepared foods; the EPOC study in Nigeria noted that economic recession led to an increased consumption of street foods because of the scarcity and high cost of obtaining ingredients (Cohen 1985). Another study in Nigeria also noted a rise in consumption of street foods following the implementation of structural adjustment programs including currency devaluation (FAO and Food Basket Foundation International 1991). The latter resulted in fewer meals being eaten at restaurants where prices had risen. Competition between vendors may also keep prices low, although, as FAO has pointed out, this can lead to purchasing of inferior raw materials that may have implications for food safety (FAO 1989). Many vendors operate elaborate pricing systems in which they may give regular customers or fellow traders a discount (Bueno 1988; Owens and Hussain 1984). Another factor that makes street foods a potentially cost-effective food is time; EPOC has drawn attention to the fact that many traditional foods involve lengthy preparation and the purchase of street foods allows women to substitute time spent in food preparation for income-generating activities (Cohen 1985).

Street foods are an accessible source of food and vendors are a ubiquitous urban phenomenon in most countries. Vendors choose their locations with care, concentrating in a variety of strategic spots, which, contrary to expectation, are not in exclusively commercial areas. EPOC found that, with the exception of Minia in Egypt, the number of

vendors correlated closely with the total urban population, which supports the assumption that there is a direct association between the number of street food enterprises and increases in city size (Tinker 1987). The highest density of vendors was found in Bogor where there were approximately 18,000 vendors in a city of about 250,000, which corresponded to 14 people per vendor. In other countries the density ranged between 34 and 69 people per vendor, but in Minia it was 255 people per vendor. It is suggested that latter figure might be due to the atypical nature[1] of the street foods sold there.

These studies point to the low cost, accessibility and convenience of street foods as key factors explaining their growing popularity, although these would need to be assessed in local contexts.

Nutrient Content

At present, virtually no chemical analyses on the nutrient content of street foods have been conducted. Because street foods vary in type so much from country to country, it is impossible to draw any general conclusions from the few analyses that have been done.

An analysis of home-cooked traditional snacks and commercially processed snack foods in Malaysia found, somewhat predictably, that the nutrient content of both snack types were highly variable and depended mainly on the composition and balance of ingredients (Tee et al. 1989). Fish and prawn products, for instance, had a higher retinol content. An evaluation of mainly commercially processed snacks eaten by children in rural India found that the snacks had a low iron content and even the total energy content was not high (Bhat and Umapathy 1986). Another study of traditional Indian cereal- and legume-based snacks found that some had a moderate iron content, but presumably also a high phytate content, which could inhibit iron absorption (Pasricha et al. 1987).

Some of the EPOC studies analyzed the nutrient content of selected street foods using local food composition tables and found that street foods can provide good value for the money. An analysis of some popular meals in the Philippines found that the meat-based dishes scored highest in terms of total energy and protein content (average 193 Kcals and 16 g protein per meal). Vegetable dishes scored higher for iron, vitamins A and C (average 2.9 mg, 434 IU and 12 mg respectively), although the bioavailability of the iron is uncertain (Barth 1983). A similar analysis of a "typically modest" Rp 300 meal in Indonesia found that it supplied approximately one-half of the energy and protein requirements (adult's presumably) and more than one-half the requirements for iron, vitamin A, and C (again, presumably those of an adult) (Chapman 1984). The meal was described as an "unsung bargain."

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[1] In Egypt, traditional food eaten at home took little time or effort to prepare, whereas the preparation of the most popular street food sold was time-consuming. This relationship between those foods eaten on the street and those eaten at home was unlike any seen in the other countries studied.

Although no FAO-supported studies have yet addressed the issue of micronutrients (Akinyele, personal communication), some FAO investigations have shown street foods to be good sources of energy and protein available at a lower cost than pre-packaged processed foods (FAO 1989). There is a critical need, however, for more precise and quantitative information on the nutrient content of street foods to assess the nutritional quality of different types of street foods and their contribution to the overall energy and nutrient intake of different population groups. This will help identify particular foods or ingredients that in terms of composition and consumption may offer potential as vehicles for fortification.

Patterns of Consumption and Contribution to Nutrient Intake

Data on the patterns of consumption of street foods and their contribution to dietary intake are scanty. The customer surveys undertaken by EPOC and other investigators revealed that the main consumers of street foods in most countries were other members of the informal sector, such as fellow hawkers and hustlers and casual wage laborers. Other important categories of customer were children and students, office workers, and housewives (Cohen 1985). The EPOC studies also found that street foods were consumed across all income groups and the proportion of the daily household food budget spent on street foods was high, ranging from 25 percent in Bogor to 47 percent in Chonburi, Thailand (Tinker 1987).

Children emerged as an important category of consumers in some countries; in Senegal, 28 percent of all street food customers were children and adolescents (Posner 1983). A study in Mali also found that children were important consumers of street foods and that they exerted considerable independence in buying food (Chauliac et al. 1994). A study of Haitian school children's consumption of street foods found that most ate them every day and that street foods provided the children with an estimated 400 Kcals per day (Webb and Hyatt 1988). As noted earlier, there is virtually no information on rural areas, but there are a few published studies which have documented the snacking habits of children as a traditional and important part of their diet (Carlin 1993; Kalissa and Monziba 1993; International Nutrition Communication Service [INCS] 1983; Montague 1985). Snacking has sometimes been viewed as a "bad" habit and snacks have been accused of displacing more nutritious items from the diet. An ethnographic study of the food habits of rural children in West Java, however, found that those children who ate more snacks also ate more meals, i.e., snacks did not replace meals (Carlin 1993).

The patterns of consumption in terms of what is eaten, when, and how often vary from country to country. EPOC found that in Senegal the main meal bought was breakfast (Posner 1983), whereas in the Philippines lunch was the most popular meal purchased (Barth 1983). Overall, snacks were the most common street food bought in the countries studied. Again, the frequency and regularity of consumption were variable: in some countries, street foods were bought daily and formed an integral part of the diet; in others,

notably Manikganj in Bangladesh, they appeared supplementary and few customers bought them daily (Owens and Hussain 1984). Some categories of consumer (students, itinerant unskilled laborers, and the homeless) were found to buy almost all their food from vendors (Bapat 1992; Chapman 1984).

Two dietary surveys conducted as part of the Bogor Streetfood Project provide the only quantitative information on the contribution of street foods to overall dietary intake. The first dietary survey, of 47 students in Bogor, found that the students got 78 percent of their energy intake, 82 percent of their protein intake, and 78 percent of their iron intake from street foods (IPB et al. 1990). Although energy intake of both men and women and the iron intake of women did not meet local recommended daily intakes, street foods served as important sources of these nutrients. Meals were the most important type of street food eaten, followed by snacks.

The second survey was a random household food consumption survey (TNO et al. 1992b). Overall, street foods made a significant contribution to the nutrient intake of adults and children by providing an average of 30 percent of their total energy intake, 26 percent of their protein intake, and 44 percent of their iron intake, but only 5 percent of their vitamin A intake. Even children under a year old were consuming significant quantities of street foods. The proportion of total nutrient intake from street foods was highest in pre-school children and lowest in pregnant mothers.

From this rather patchy information, it is possible to conclude only that there are regional differences in the pattern of consumption of street foods. In some places street foods appear to form an integral and substantial part of the whole diet, and some groups, such as students and the homeless, are almost totally reliant on them. Although in some countries street foods form a traditional part of the diet and serve as a way of conserving traditional food habits (FAO 1992), the rise in consumption of street foods in most countries is part of broader patterns of change associated with urbanization. The results of a survey conducted by WHO in 1993 of its member states showed that 74 percent of countries considered that street foods constituted a significant part of the urban food supply (WHO 1995).

Much more information is needed on the consumption patterns of street foods in terms of who eats them; what types of foods are eaten and in what quantity; and their contribution to overall dietary intake. Information is also needed on the place of street foods within the context of changes in dietary patterns associated with urbanization. Little is as yet known about this and, as Atkinson (1992) has pointed out, the factors that influence urban food security are different from those that influence the food security of rural populations, and the social dynamics of the urban poor are not well understood.

Food Safety and Regulatory Aspects

The safety of street foods is a major consideration, which deserves and has received considerable attention. The main health hazard associated with street foods is microbial contamination but pesticide residues, transmission of parasites, the use of unpermitted chemical additives, and environmental contamination have also been identified as possible hazards (Abdussalam and Kaferstein, 1993; Arambulo, III, et al. 1994).

Microbial Contamination

The potential for the contamination of street foods with pathogenic micro-organisms has been well documented and several outbreaks of disease, including cholera outbreaks, have been traced to consumption of contaminated street foods (Abdussalam and Kaferstein 1993).

The risk of contamination varies greatly with the type of street food and how the food is prepared. Generally, cereal and bakery products with a low moisture content, products that have been adequately sugared, salted, or acidulated, and some fermented products support bacterial growth less readily than dairy, egg, and meat products. Foods that are cooked immediately prior to consumption are safer than those which have been cooked and stored at ambient temperature (WHO 1992). Dishes containing raw ingredients or made with ice are also high risk items (Arambulo, III, et al. 1994). Other factors implicated in causing microbial contamination include poor food preparation and handling practices, inadequate storage facilities, the personal hygiene of vendors, and a lack of adequate sanitation and refuse disposal facilities (Abdussalam and Kaferstein 1993).

The health risk posed by street foods, however, may be no greater than that posed by foods from other sources (Abdussalam and Kaferstein 1993). Two studies conducted in India (Pune and Calcutta), for instance, found that the microbial quality of street foods was equivalent to, if not better, than that of foods bought from hotels and restaurants (Bapat 1992; Chakravarty 1994). Female street food vendors have been found to have better hygienic practices than do their male counterparts (Dawson and Canet 1991). EPOC has made the pragmatic point that the hygienic quality of street foods is unlikely to be any worse than that of foods prepared at home, particularly in poorer households, and from their studies concluded that the microbial quality of street foods was in general equivalent to or better than that of foods prepared by customers at home. Despite this, the questionable safety of street foods is a limitation to their promotion and efforts to improve microbial quality should be a part of any intervention program targeted at street foods.

Many interventions have been suggested to improve the hygiene of street foods, including education and training programs for vendors, the improvement of vendors' equipment for preparation and storage, the provision of adequate sanitation and refuse disposal facilities, and the provision of special food centers (WHO 1992). As a component of most street

foods, safe water supplies are essential. Appropriate food hygiene legislation and systems of enforcement are also needed (see below). This is an area of conflicting technical approaches, but both WHO and PAHO recommend the use of a hazard analysis critical control point (HACCP) approach as the most cost-effective and flexible means to improve the safety of street foods in the diverse conditions in which they are made (Bryan 1992; Arambulo, III, et al. 1994). The HACCP approach can be applied at any step of the food chain to identify and characterize the critical points where risk occurs and to establish priorities for intervention and control. This information can be used to set priorities, formulate interventions, and identify the needs of vendors and customers for education and training. Pilot projects using the HACCP approach are planned by WHO, and it is possible that such an approach could be combined with interventions to improve the nutritional quality of street foods. Other organizations have developed standards and codes to detail food safety problems and approaches for correction.

Chemical Contamination

Non-food grade chemical additives, such as colorants and preservatives, and contaminants, such as pesticide residues, have also been found in street foods. A chemical analysis of street foods in Bogor found unpermitted coloring agents such as textile dyes and also pesticide residues (IPB et al. 1990). Proper use of salt, spices, nitrates, and sugar are an important means of preventing food spoilage, but the drive to keep prices down may lead to the purchase of cheap ingredients containing unpermitted chemical additives from unauthorized suppliers. Chemicals such as colorants may also be added to mask the poor quality of cheap materials. Uniform and universal availability of good quality ingredients is vital. Again, there is a need for legislation and control because adulteration of foods is a major consumer concern.

Regulatory Aspects

Food legislation and regulatory control of street foods varies from country to country. A recent review of the situation in Asia found great diversity among the legal instruments developed to control the street food trade. Some countries had no specific legislation or control systems at all (Jayasuriya 1994). In those countries where street food activities were regulated by law, the regulations or by-laws affecting the street food trade were part of a larger body of legislation dealing with food, health, or environmental sanitation. Licensing or registration systems, inspection systems, and codes of practice are other forms of regulation that are in effect in some countries.

The Codex Committee on Food Hygiene tried to develop an international code of hygienic practice for street foods to serve as a model for regional and local codes. Because of the wide diversity in local food preparation practices, this was abandoned as being impossible at the Committee's 26th session (1993). It was recognized that national governments needed to be involved in order to take local situations and needs into consideration. The

draft code was then sent to the Codex Regional Committees for further consideration and, at the last Codex meeting, *The Regional Code of Hygienic Practice for the Preparation and Sale of Street Vended Food Alinorm 95/36 for Latin America and the Caribbean* was adopted (reproduced in appendix 2). Regional codes for Africa and Asia are still progressing through the Codex system. These codes are intended for adoption by individual governments. They carry the benefit of defining general principles but, because of the heterogeneity of street foods and the conditions in which they are prepared, they cannot accommodate the almost infinite number of possibilities in each situation.

WHO has also issued safety requirements for street foods intended to form the basis of national guidelines (WHO 1992), and these have recently been updated (WHO 1995). The new strategy promoted by WHO is based on the HACCP approach described above, rather than the traditional code of practice approach.

Official Attitudes

The informal sector as a whole has been viewed by many governments as a marginal activity, which, according to "modernization theory," should ultimately be absorbed by the "modern" capitalist sector. That this has not happened and that the street food trade has in fact flourished has not, however, led many governments to look kindly on the street food trade. In many countries, the street food trade is not officially recognized and vendors operate unlicensed and unregulated. At best, the attitude of most governments is to either ignore or tolerate it, but in some places vendors suffer active harassment.

A small number of countries have recognized the street food trade. Singapore, for instance, has incorporated the street food trade within city planning and tourist development schemes (Jayasuriya 1994). Vendors have been relocated in food centers and markets, and over 20,000 vendors are now licensed. The licensing requirements include certain health specifications, such as regular typhoid vaccination (Dawson and Canet 1991). There is a danger, however, of over-regulation; the street food trade and the informal sector, as a whole, provides livelihoods and means of income generation that many governments and the formal sector are unable to provide. A repressive licensing system would only further marginalize the street food trade and make those engaged in it less interested in participating in interventions.

Trial Interventions

Very few interventions in the street food trade have been conducted. Those that have been reported have focused almost exclusively on the improvement of the safety of street foods. As mentioned earlier, FAO, WHO, and PAHO have been the lead international agencies in this area and various types of interventions have been carried out, including training programs for vendors to improve food handling practices, the development of improved equipment, and efforts to develop an appropriate regulatory environment (selected food

safety studies and interventions are also included in appendix 1).

Various trial interventions were conducted as part of the Bogor Streetfood Project, which, although many were also aimed at the food safety aspects of street foods, are pertinent to the objectives of this review because they explored in depth the socio-economic potential of the street food trade in Bogor and the interest and response of street food entrepreneurs to the interventions.

The Bogor Trial Interventions

The overall objectives of the interventions carried out as part of the Bogor Streetfood Project were threefold: (1) to improve the quality and safety of street foods; (2) to strengthen the socio-economic base of the street food trade; and (3) to develop policy recommendations for local, regional, and national governments. The results of earlier detailed studies of the production, distribution, and consumption of street foods were used in the design of the trial interventions described above. The following discussion describes a pilot extension program for street food vendors and producers (TNO et al. 1992c).

The pilot extension program comprised four modules: (I) introduction and problem identification, (II) food handling, (III) self-organization, and (IV) managing micro-enterprises. These were administered to four target groups who were selected to represent the different types of entrepreneurs identified in the earlier studies. Group-based approaches were used to introduce the modules. In brief, they found that those groups that were initially well-organized benefited most from the program in terms of developing self-organization and identifying and pursuing common goals together. Overall, the street food vendors and producers were motivated and greatly increased their knowledge of food hygiene. Their actual food handling practices did not improve substantially, however. This was partially attributed to the lack of social control to promote adherence to new food handling practices, particularly in those groups with weaker self-organization. All groups felt that the extension program was useful, but wanted some form of after-care or support.

Although extrapolations cannot be made from these data about the nature of the organization of the street food trade in other contexts, the Bogor studies and trial interventions illustrate several important general issues relating to the design and implementation of appropriate and sustainable interventions in the street food trade:

- if the nutritional quality of street foods is to be improved, then the needs and problems of the street food traders themselves must also be addressed;

- the need to understand the social organization and socio-economic characteristics of street food traders and how they may differ;
- the special needs of women entrepreneurs who may combine running their street food business with other responsibilities, such as child care, and have limited time to

participate in intervention programs;

- the need to integrate the street food trade into local policy and planning processes to address wider environmental problems, such as lack of access to water supplies and waste disposal facilities; to improve the safety of street foods.

Summary

The street food trade provides an important source of both income and food in many urban and peri-urban contexts in developing countries. It is a complex sector that includes food processing and distribution activities as well as the retail of foods on the street. It also provides an outlet for local agricultural produce and the products of small-scale producers and large-scale formal sector food processors. The composition and organization of the trade varies according to context, although it is dominated by small-scale, often household-based, enterprises. Street foods occupy an important place in the diet, are eaten by many people, and provide an affordable and accessible source of food. Most customers form a part of the same informal economic sector as the vendors themselves, but school children and students are an important category of consumers in many countries.

Despite the magnitude of the street food trade, it has received little support and is generally excluded from official planning and development processes and its potential role in improving urban food security is ignored. Atkinson (1992) and EPOC (Tinker and Cohen 1986) recommend that government and planners should support the trade because:

- it has implications for domestic agricultural production and rural incomes;

- it provides a source of low-cost food in urban contexts and is an important part of the total urban food system;

- street food could be a means of introducing new foods to consumers, and vendors could be employed in cooperative ventures by urban authorities to provide low-cost nutritious meals for pre-school and school feeding programs.

The trade is also an important source of income and employment for urban populations. Much more information is needed, however, on the organization of the street food trade, the types and composition of street foods, and their production and consumption in specific country contexts to assess the potential for intervention and the type of intervention that would be appropriate.

THE POTENTIAL FOR MICRONUTRIENT FORTIFICATION

The fortification of foods is a widely used method for the delivery of micronutrients. The food utilized for fortification can be selected to deliver the nutrient(s) to a target population effectively, uniformly, safely, and at minimum cost. Fortification programs have been effectively implemented in both developed and developing countries to provide a variety of nutrients. Many different foods have been used as vehicles, but the potential of street foods for micronutrient fortification has not as yet been considered.

The Codex Committee on Nutrition and Foods for Special Dietary Uses defines two different types of fortification: (1) fortification or enrichment, which is "the addition of one or more essential nutrients to a food whether or not it is normally contained in the food for the purpose of preventing or correcting a demonstrated deficiency in the population or specific population groups"; and (2) restoration, which is "the addition of essential nutrient(s) which are lost during the course of good manufacturing practice, or during normal storage and handling procedures, in amounts that will result in the presence in the food of the levels of the nutrient(s) present in the edible portion of the food before processing, storage or handling" (Codex Alimentarius Commission 1994). It is the former that is discussed here, although it should be noted that this definition of fortification merges fortification (the addition of a nutrient to a vehicle that may not normally contain that nutrient) with supplementation (raising the level of an existing nutrient to significant levels). Fortification and supplementation are sometimes defined separately, for instance in the U.S. regulations (United States Food and Drug Administration 1987). The Codex General Principles for the Addition of Essential Nutrients to Foods (CAC/GL 09-1987) are contained in volume 4 of the Codex Alimentarius (Codex Alimentarius Commission 1994).

Several issues need to be taken into account when assessing the potential viability and efficacy of a fortification program. Central considerations include the identification of a compatible vehicle, the need for uniform consumption, reasonable cost, and quality control. Street foods present a unique challenge because of their great diversity in composition, consumption, and the ways in which they have been processed. Fortification of street foods may not be possible in all cases because of this heterogeneity and the consequent lack of a single suitable vehicle. In addition, there are difficulties involved in implementation and quality control. An evaluation of the potential of street foods for micronutrient fortification is hampered by the lack of detailed information available on the types of street foods being sold, their nutrient composition, consumption patterns, and methods of processing. This makes it impossible to evaluate the potential of specific foods for fortification in particular country contexts. The discussion here, therefore, addresses potential opportunities and constraints from two broad perspectives: (1) in relation to street foods themselves and whether they may offer suitable vehicles for fortification; and (2) in relation to the groups who would be involved in a fortification program, both the intended recipients of the fortification and those who would be

involved in its implementation. Issues such as food safety, regulations, and policy aspects will also be considered. The efficacy of fortification in combating micronutrient malnutrition versus other types of intervention, such as the use of pharmaceutical supplements, will not be discussed.

Technical issues involved in the implementation of food fortification programs include choice of an appropriate fortificant, specification of levels of fortification, and the equipment needed to introduce the selected fortificants into the selected food. These decisions require precise quantitative information on, among other things, the composition and consumption of the selected food vehicle(s), methods of food processing, and the extent and distribution of micronutrient deficiency in a particular population. Because this is not intended to be a technical manual, these issues are not discussed exhaustively, but only as they pertain to the potential for the fortification of street foods. For a detailed discussion of these issues see Nestel (1993).

The Suitability of Street Foods as Food Vehicles

The identification of an appropriate food vehicle is one of the critical challenges in planning a successful fortification program. Factors that determine the suitability of a particular food include processing and organizational considerations as well as the consumption patterns and purchasing power of the intended target group. Food vehicles previously used in developing countries have mostly been staple foods derived from commodities or with commodities as an essential component. Examples include cereals and cereal-based foods, salt, and sugar. Fortified foods have also been formulated for specific target populations; the best examples are infant formulae, beverages, and complementary foods for infants and young children. In developed countries, many foods have been used, including staple foods and processed products. The most common foods fortified are milk, margarine, and cereals. For some -- such as margarine in the U.S. and U.K. -- fortification with micronutrients (vitamins A and D) is mandatory, but for many others, such as breakfast cereals and snacks, fortification is increasingly being used as a selling point to enhance consumer appeal. This raises issues regarding labeling and advertising claims.

The conventional prerequisites (Arroyave 1992; Brubacher 1991; Cook and Reusser 1983; Hurrell and Cook 1990) for a suitable food vehicle specify that it should be:

- centrally processed and distributed;
- consumed regularly and uniformly by the target population;
- chemically suited to fortification.

As discussed above, street foods are extremely diverse and vary according to meal type, number and type of ingredients, nutrient composition, methods of processing, retail location, and consumption. This heterogeneity has important implications for the feasibility, reliability, and efficacy of fortifying street foods with micronutrients. Preliminary studies are essential to identify the extremes of variation in each of these parameters in specific contexts. The implications are profound and all factors relating to the diversity of production, consumption, and composition of street foods need to be considered in relation to each of the prerequisites listed above. These are described further below. Another consideration is whether the fortification should be universal or targeted at a specific population group(s).

Processing Requirements

The preparation of street foods and the processing of ingredients must be examined in order to determine if there is a universal point of processing where fortification could be incorporated. It is essential that a vehicle selected for fortification is processed, at least to some degree, because fortification is by necessity a step in processing. A food that receives little or no processing offers no potential for fortification.

An additional reason for central processing involves implementation and control of the quantities of fortificant. Uniformity is necessary to ensure effective delivery and to avoid addition of excessive amounts. The latter is important, even though toxicity due to excessive intakes is unlikely to occur. Nonetheless, regulatory, monitoring, and enforcement procedures must be present to ensure quality control. The fortification of foods and food products that have been produced by many small producers is logistically impossible to implement and control. This is particularly true in developing countries with limited infrastructure.

Proceeding from this basic requirement for the selection of a fortification vehicle, a vital distinction needs to be made between: (1) foods prepared "on the street," either by the vendor or another small-scale operative within the informal sector; and (2) foods prepared at a central location for the most part, but modified, distributed and sold by street food vendors. This division suggests two parallel strategies for fortification: (1) ingredient-based fortification of universal processed ingredients, such as flour, used in the preparation of foods "on the street"; and (2) food-based fortification of centrally processed ready-to-eat foods, such as corn chips, sold by street food vendors.

A classification of the level and type of processing of street foods and their ingredients provides a broad overview of the opportunities and constraints for fortification of food vehicles in relation to these two options. The following classification is based on that of Edmister and Kuipers (1989):

- Minimal processing and preparation carried out by the vendor, usually on-site prior to sale, for instance peeling, slicing, and roasting fruit, nuts, pulses, and vegetables, or boiling, frying, and steaming foods. These foods offer no potential for fortification.

- Small-scale processing carried out within the informal sector by the vendor or other multiple small-scale producers using traditional low-volume food technologies. Common products may be traditional flour-based cakes and snacks, confectionery, traditional beverages such as fermented cereal drinks and tonics, and condiments.

  If it is possible to identify universal ingredient(s) in these foods, such as cereal flours, which have passed through centralized processing, then these ingredients may offer potential for fortification at source.

- Large-scale processing carried out by the formal sector food industry. Their products include ingredients, such as milled cereals and cereal-based foods, salt, sugar, condiments, cooking oils, and ready-to-eat items, such as packaged biscuits and snacks, confectionery, ice cream, and bottled beverages.

  This category encompasses both ready-to-eat foods and ingredients which are used in the preparation of street foods. Both of these may offer potential for fortification.

The ways in which street foods are sold and eaten, therefore, need to be examined to see whether it is possible to identify foods that contain ingredients that have been centrally processed or the street foods have themselves been centrally processed. This information is currently lacking and an analysis of all the steps involved in the processing and preparation of locally available street foods and their ingredients would be an essential baseline activity in any intervention program.

Ingredient-based Fortification

Ingredient fortification requires a basic familiarity with all the steps involved in the processing and subsequent use of that ingredient.

Probably the most basic fortification practiced involves wheat flour. The milling process entails separation of the different wheat fractions -- hulls, bran, and germ from wheat starch -- followed by milling of the remainder into flour. Fortification is accomplished by introduction of the fortificant(s) into the flour stream during milling. Thorough mixing follows and the flour is not subjected to any further harsh treatment or separation. The flour can then be used to make multiple foods, such as bread, noodles, pasta, and so forth at central locations, or it can be used as an ingredient in the final preparation of consumer foods. Final "on site" preparation may take the form of baking, recipe preparation, or cooking. The commercial manufacture of noodles or pasta uses flour as a basic ingredient, but involves the addition of water and other characteristic ingredients such as salt, flavors,

and enzymes. Fortification can occur either during the basic flour making process or can be added as an ingredient during the preparation of the noodles. Final preparation involves on-site cooking and incorporation into traditional recipes.

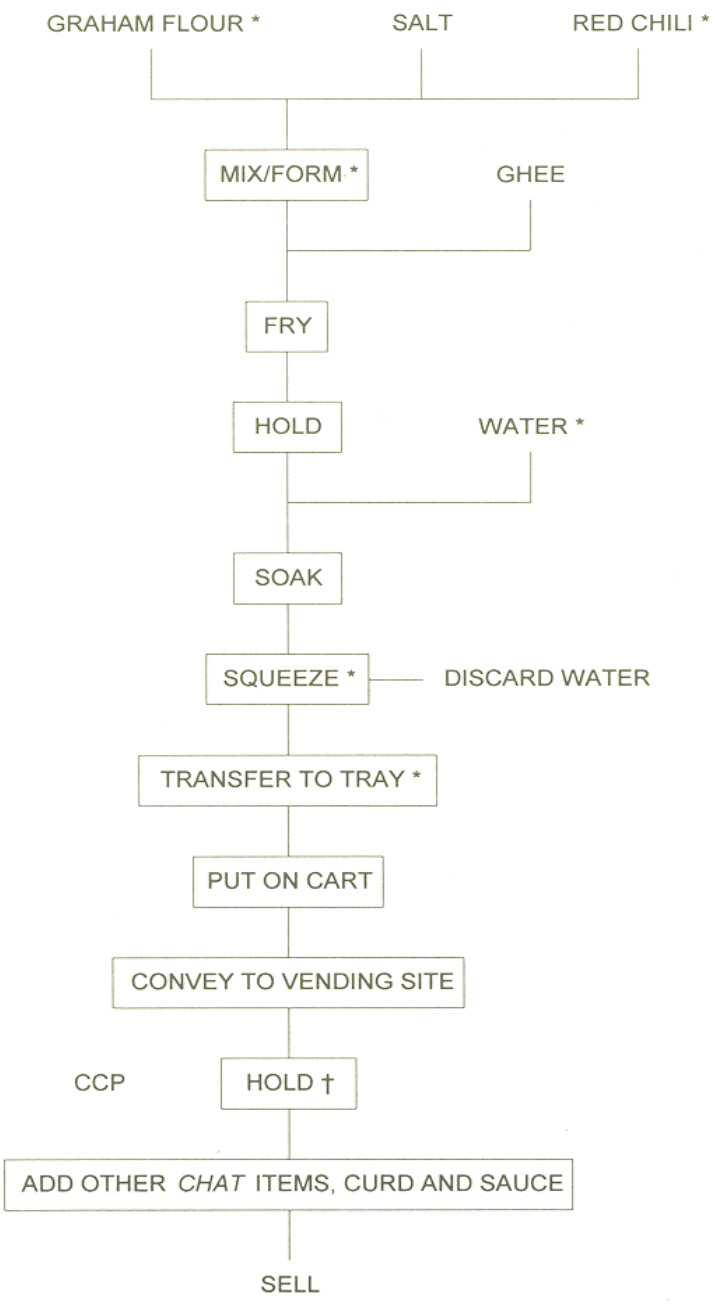
Salt iodization is perhaps the most common example of fortification of a food ingredient. A stable iodine compound (usually potassium iodate) is added to salt after the final crystallization and prior to drying. Salt is universally used by all societies as an ingredient or food condiment. The quantities available are adequate to fulfill nutrient requirements for iodine through normal usage.

All the complexities of processing, formulation, and final preparation should be considered for each food ingredient being evaluated for fortification. A flow diagram, similar to those used for the HACCP approach to food safety recommended by WHO (WHO 1995) and PAHO (Arambulo, III, et al. 1994), may provide a useful overview of these steps. Likewise, the HACCP principles may be applicable. In order to identify, evaluate, and control the hazards that are significant in relation to food safety, all the steps in the food chain from primary production to final consumption must be systematically observed and described, including information on composition and distribution. An example is given below of a HACCP diagram which illustrates all the ingredients and processing steps involved in the preparation of *boondi*, a component of *chat*, which is a popular street food in Pakistan. The *boondi* and other components of *chat* are prepared off site, conveyed, and held on site where they are assembled into the final dish. The other components of the final dish are sliced cooked potatoes, *bhalla* (a pulse flour-based dish whose preparation is very similar to the *boondi*), chick peas or red peas, and a garnish of *lassi* and fruit syrup.

Such an approach allows identification of hazards and also of the critical control points (CCPs) -- steps in the food chain at which it is possible to intervene to prevent, eliminate, or reduce these hazards. The improvement of the nutritional quality of street foods could provide an entry point for the improvement of food safety.

A major potential constraint to a HACCP approach to fortification may be the large number and different types of producers and suppliers that are involved in many of these steps: it has been estimated that over 80 percent of the food plants in developing countries are small-scale and family operated (Weber 1987). This may vary for different commodities. The milling and cereal-processing industry, for example, is an important industry in many developing countries, but often encompasses numerous small-scale rural enterprises processing locally produced grains, as well as large urban-based plants that process large quantities of grains mainly for urban markets. Wheat is commonly an imported commodity in many developing countries and often passes through a centralized milling process. Wheat flour has been identified as a suitable vehicle for fortification in several programs, for instance in Sri Lanka and the Philippines, despite not being the staple cereal. In these countries it is processed either by centralized bakeries into bread, or

Figure 1: Preparation and Holding of *Boondi*



Legend
* Hazard of contamination likely
† Hazard of bacterial growth likely
CCP Critical control point

Source: Bryan, Teufel, Riaz, Roohi, Qadar and Malik (1992a)

by individual operators, often street food vendors, into local foods, such as roti (Sri Lanka) and pan de sal (the Philippines), which are consumed in significant amounts by the poor. Noodles have been identified as a food vehicle appropriate for fortification in Southeast Asia, as they could link large-scale processors with street food micro-enterprises (Winarno, personal communication). Sugar and salt are successfully used as fortification vehicles in many countries. In Guatemala, Honduras, and El Salvador, for example, all sugar for direct consumption must be fortified with vitamin A, even though adequate fortification facilities are sometimes lacking. Salt fortification with iodine is a common and successful practice in many areas of the world, and a universal program for salt iodization would successfully encompass street foods.

All the steps involved in the delivery of foods and food ingredients to the consumer must be considered and evaluated. The earlier considerations have focused on vehicle description, selection, and preparation. The delivery, which includes packaging, storage after processing, transportation, and storage at use site, is a critical consideration. Most developing countries lack the infrastructure to adequately protect foods during delivery, and fortification programs should recognize and accommodate this situation. This also relates to the suitability of particular items in chemical terms; shelf life stabilities may be reduced by fortification with iron, for instance. This is discussed further in the section below on chemical requirements and more examples are given there of food vehicles used to date.

Food-based Fortification

The fortification of commercially processed ready-to-eat foods sold by street food vendors would circumvent many of the problems described for foods prepared "on the street." The possibility of developing fortified foods, such as snacks or noodles, targeted at specific population groups is relatively unexplored in developing countries.

A number of trials on the efficacy of fortified foods have shown positive biological outcomes (Mariath et al. 1989), such as one in Chile where school biscuits were fortified with hemoglobin (Walter et al. 1993) and another in Brazil, where beta-carotene-rich buriti sweets were used (Nogueira et al. 1992). However, there has been no assessment of the efficacy of commercially retailed fortified products. Niche marketing of products is successfully practiced in developed countries and there is one published report of the successful development of a nutritionally balanced snack food targeted at children in Thailand (Sinthavalai and Earle 1985). This is an area that could be investigated, although concern has been expressed over fortification of such specialty foods because of potential irregularity in consumption. It has been recommended that fortified specialty foods should be administered via controlled distribution networks, such as school feeding programs, rather than on the open market (Trowbridge et al. 1993). Also, there is a danger of market-driven fortification and the promotion of foods, such as confectionery, that are not usually recommended as part of a balanced diet (British Nutrition Foundation 1994). This may

lead to a clash with other nutrition education messages. Although, as discussed in the previous section, the consumption of snacks does not necessarily displace other foods from the diet. The consumption of such products and their relation to overall food intake in the intended target group would need to be examined.

Another potential limitation to the presentation of prepared fortified foods is cost. Processing, packaging, storage, and delivery of foods by the food industry involves expense and, as a result, the cost of processed foods is greater than that of unprocessed ingredients. The value added is generally recognized, but, in relation to street foods, it would need to be examined whether the increase in cost would deter the intended customers. In many countries, subsidizing the food supply is a part of government policy, so subsidization of fortified processed foods to make them competitive with unprocessed foods might be possible.

Consumption Requirements

The prerequisite of regular and uniform consumption of the intended food vehicle(s) by the intended target group is vital if a safe and constant dose of the selected micronutrient(s) is to be administered.

Despite the lack of detailed quantitative information on the consumption of street foods, the information currently available indicates that some street foods may offer potential in this respect: they are cheap and widely available, they form an integral and substantial part of the diet in many countries, they are bought and consumed with regularity and consistency, and they are consumed by all income groups, but particularly by the urban poor. Children were found to be an important category of consumers in many places, and some people, such as students and itinerant workers, were found to be almost totally reliant on street foods. This raises the possibility of targeting particular population groups via street foods, perhaps by fortifying particular foods consumed by those groups. In addition, the fortification of street foods would be taking advantage of changes in consumption patterns associated with urbanization--namely the rise in consumption of food away from home and the increase in consumption of street foods--trends that are unlikely to reverse.

Both quantitative and qualitative information is needed, however, about the consumption of specific types of street foods by different population groups, in particular contexts, and the contribution of street foods to overall dietary intake. This would help to identify particular food types (whole meals, constituents of meals, food accessories, snacks, confectionery, and beverages) that are eaten in sufficient quantities and with sufficient regularity by the intended target groups. Both the upper and lower levels of intake need to be known and the risk of possible over-consumption assessed.

Chemical Requirements

Finally, a food vehicle should be chemically suitable, not adversely affect the bioavailability of the added fortificant(s), and its organoleptic (taste, smell, color) and functional properties (stability and shelf-life) should not be affected by fortification under usual conditions of storage and use. These qualities need to be considered in tandem with the choice of fortificant, because the suitability of a particular vehicle will be specific to a particular fortificant. The chemical requirements for food vehicles described below assume that a universal ingredient or centrally processed food item can be identified.

Fortificant is the term used to refer to the chemical compound which is added to a food in the fortification process. For each micronutrient, there are a number of compounds available. There is not currently a Codex list of vitamins and minerals approved for use in food fortification, although Codex is currently considering draft guidelines for dietary supplements that contain indicative lists. The *Codex General Principles for the Addition of Essential Nutrients to Foods* (CAC/GL 09-1987) contains advisory lists of mineral salts and vitamin compounds for use in foods for infants and children (see appendix 3). Multi-purpose multi-mixes combining more than one micronutrient compound are now available. These can be used to address co-existing micronutrient deficiencies and so may be more cost-effective (Nestel 1993). Fortificants differ in their bioavailability, organoleptic, and functional properties, and different compounds are suited to different food vehicles. The levels of fortificant to be added to the food vehicle are important; the concentration of the fortificant(s) in the foods must be adequate to deliver an effective dose or the fortification program will be ineffective. The specification of the appropriate levels of fortification requires quantitative information on patterns of food consumption within the target population. For the calculations to determine a safe level of fortification see Nestel (1993).

The bioavailability of the added micronutrients as consumed needs to be good or fortification will be ineffective in terms of biological outcome. If the organoleptic properties of the fortified food are not acceptable to the target group, the food will not be eaten. The stability of the fortified product can affect both of these outcomes and the effects of processing, storage, distribution, and preparation practices on them also need to be considered. Encapsulated fortificants have been developed which are relatively immune to heat-, moisture-, and oxygen-induced degradation and so survive the effects of downstream processing and storage well, but these are much more costly than unencapsulated forms (Maxwell 1990). The cost of fortificants is an important consideration because, after initial start-up costs, their purchase often represents the main operational cost of fortification programs. The prices of chemical fortificants vary, but nearly all are manufactured by Western pharmaceutical companies, such as Hoffmann-LaRoche, and their purchase requires foreign exchange. This may affect the long-term sustainability of fortification programs.

Street foods themselves are extremely varied in terms of their ingredients and overall chemical composition. The popular foods listed in the Indonesian country report (Chapman 1984), for instance, encompass rice-based dishes with side dishes of meat, fish, crustaceans, soy products such as tempe, vegetables, fried snacks made from a variety of ingredients, traditional cakes made with rice and wheat flour, porridges made from cereals and pulses, a wide range of beverages, and fruit. To identify a universal ingredient that is suitable for fortification in chemical terms, information is needed on the number, type, and quantity of all ingredients present in particular foods, how they are prepared and eaten, and their overall chemical composition and suitability. Information is also needed on the source of ingredients, patterns of procurement, storage, and use because downstream processing and storage can significantly affect the bioavailability, organoleptic, and functional properties of the fortified product. Because of the dearth of data available on these aspects of street foods, it is not possible to identify particular foods or ingredients that are suitable for micronutrient fortification. The main chemical requirements relating to fortification with iron, vitamin A, and iodine, along with food vehicles which have been used to date, are described briefly below. See Nestel (1993) for a fuller description.

Iron

Fortification with iron presents a greater challenge than most other micronutrients. Most fortificants are inorganic iron compounds whose bioavailability is extremely variable and is greatly affected not only by the chemical composition of their food vehicle, but also by that of the whole meal in which they are consumed. There are many factors which reduce the bioavailability of iron, the main ones being phytates and oxalates (cereals and pulses), polyphenols including tannins (tea and coffee), soy protein, and phosphatin (eggs). Factors which enhance bioavailibility are organic acids, notably ascorbic acid or vitamin C, animal protein, a low pH as in fermented foods, and alcohol. It has been recommended that the bioavailability of fortificant iron in typical foods eaten as part of the normal diet should be part of a feasibility study of fortification (Baynes and Bothwell, 1990).

Unfortunately, the more bioavailable soluble compounds, such as ferrous sulphate, also tend to be the most reactive and can catalyze oxidative reactions causing unpleasant smells and colors (Cook and Reusser 1983). This reduces the shelf life of the fortified products and there is an inverse association between shelf life and stability. Color changes can also be a problem with pale foods, such as rice, and in foods which are eaten in small amounts, such as sugar and salt, where fortificant levels are relatively concentrated. Colored foods with strong flavors are more suited to fortification with reactive iron compounds. Insoluble phosphate compounds cause fewer organoleptic and storage problems, but have a low bioavailability. Ascorbic acid can be added to improve absorption, but this will increase costs and would be prohibitively expensive on a national scale (Cook and Reusser 1983).

Sodium iron EDTA and organic hemoglobin are iron complexes whose bioavailability is good and relatively unaffected by other food components. EDTA is an approved food additive and iron EDTA was given provisional approval by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 1993 for use in food fortification programs. Bovine hemoglobin has been used in Chile and Brazil (Nogueira et al. 1992; Walter et al. 1993), but requires a constant supply of uncontaminated blood, imparts a strong color to foods, and would be culturally unacceptable in some countries. It also carries potential health risks and its use would require a rigorous quality control system.

Food vehicles used for iron fortification to date include cereals and cereal products (wheat and corn flour), and complementary foods for infants and young children. Small-scale studies have been conducted on rice, maize meal, noodles, curry powder, fish sauce, dairy products, biscuits, water, beverages, salt, and sugar (Cook and Reusser 1983; Nestel 1993; Preet Kaur et al. 1988; Zoller et al. 1980). Although some of these field studies have shown favorable results, many have not been scaled-up because of technical and distribution problems, which include lack of centralized processing (fish sauce), lack of consumption by the vulnerable groups (wheat), discoloration (sugar), and cost (sugar and salt).

Vitamin A

Retinoid compounds are available in various wet and dry forms for fortification, the choice depending upon the type of food vehicle (water- or oil-based or dry) and how it is used. The organoleptic and bioavailability properties of these compounds are good. Conditions of storage and use are particularly important for vitamin A; the stability of vitamin A compounds is reduced by exposure to air, ultraviolet light, heat, moisture, and acidity. Vitamin A is also susceptible to oxidation, although antioxidants can be added to protect against this.

Beta-carotene can also be used as a fortificant and is already used in some countries as a food colorant (Charleux 1991). It is unknown, however, if the levels at which it is added are high enough to make a significant contribution to overall vitamin A intake.

Vitamin A fortification vehicles have, to date, included sugar, skim milk preparations, complementary foods, and margarine. Studies have been conducted on fortifying cereals (wheat and rice), monosodium glutamate (MSG), cooking oil, and tea (Bauernfeind 1978; Favaro et al. 1991; Favaro et al. 1992; Nestel 1993; Underwood 1990). Problems which have prevented scaling-up of these experimental foods include technical problems, such as stability and/or discoloration (cooking oil and MSG), lack of governmental and/or industry support (wheat and tea), and cost (salt).

Iodine

Potassium iodide or iodate are the main chemical forms of iodine used for fortification, with the latter generally preferred because it is more stable. Losses can occur through exposure to moisture, heat, light, and air. Washing salt before use can also result in iodine loss.

Salt is the most widely used vehicle for iodine fortification, but brick tea is used in Tibet and West China and there have been studies on the feasibility of using sugar, confectionery, and water (Nestel, 1993).

Other Options

An alternative to chemical fortificants is a food-based approach using locally available and culturally acceptable micronutrient-rich foods to improve the micronutrient content of street foods. These could be incorporated at the community or street level. Food-based approaches have been recommended as a feasible and cost-effective strategy to prevent micronutrient malnutrition (Trowbridge et al. 1993) and indigenous micronutrient-rich foods, such as the Brazilian buriti fruit, should be further investigated. Another option in relation to iron is the improvement of iron bioavailibility.

Vitamin A-rich foods offer the most potential as alternatives to chemical fortification because they are diverse and available. Although the availability of plant sources--such as dark green leafy vegetables and yellow-orange fruits--is subject to seasonal variation, there are technologies available to preserve some of these foods. Solar drying of fruits, for instance, has been investigated by food technologists, and some projects have linked the development of food processing technologies with income-generating programs (Edmister and Kuipers 1989).

However, a recent study in Indonesia raised questions about the efficacy of improving micronutrient status, specifically of vitamin A, by food-based approaches (de Pee et al. 1995) because it showed that women's vitamin A levels did not improve even when they ate more dark green leafy vegetables. Their baseline vitamin A status, however, may have affected the response to the supplements of locally available dark green leafy vegetables as few of the women in the study were severely vitamin A deficient in the first place, and increases in serum retinol levels are greatest in those who have severe rather than mild or moderate vitamin A deficiency (Sommer and West 1996). Also, as the authors of the study suggest, there may be differences in the bioavailability of carotenoids from different plant sources, such as fruits and vegetables. This is another area which requires investigation.

Iron-rich foods offer less potential as alternatives to fortification because foods containing iron of high bioavailability, such as meat and meat products, often tend to be expensive.

The bioavailability of iron from more widely available plant foodstuffs, such as pulses, tends to be low. As discussed above, however, there are many dietary components which can increase the bioavailibility of iron, notably vitamin C. Foods rich in vitamin C could be added to the diet to improve bioavailability. Vitamin C is the most important enhancer of iron absorption in developing countries, and as little as 50 mg can double iron absorption (DeMaeyer 1989). Fermentation and germination, which are traditional food technologies in many countries, have been suggested as a means to improve iron bioavailability. In vitro experiments have demonstrated an increase in soluble iron in cereal porridges due to phytate hydrolysis (Svanberg et al. 1993), but there has been no in vivo assessment.

The iodine content of foods reflects the amount present in the environment in which it was grown; thus locally grown foods in an iodine deficient area will have a low iodine content. Marine fish and other seafoods are good sources and could be used if available, but are likely to be expensive and unavailable in inland areas. The use of iodine-rich foods offers the least potential for food-based approaches, although iodized salt should be used.

Program Considerations

The implementation and efficacy of a fortification program of street foods would require, depending upon the vehicle chosen, the participation and support of some or all of the following groups:

- consumers and consumer organizations;
- informal sector street food vendors and producers;
- formal sector food and commodity processors;
- government and regulatory bodies.

In some contexts these categories may overlap, but for the purposes of this discussion it is useful to consider each as a separate group because they differ in the way in which they would be involved in a fortification program, their motives, and the incentives that they might require. Despite the often divergent interests of these groups, broad involvement and understanding is critical for successful fortification programs. Inclusion of scientific, medical, and technical representation is generally recognized. Policy commitment is also necessary and should involve regulatory and food hygiene officials, finance, and the sector responsible for the evaluation of cost-benefit relationships. Consumer representatives within the political process can provide adequate understanding of the benefits to be derived from fortification.

Consumers and Consumer Organizations

The principal issues in relation to these groups are acceptability, promotion, education, and food safety.

Acceptability

It is assumed here that those who eat street foods correspond to the intended target group. Consumers are involved in fortification programs in a relatively passive way in that no demand is made of them other than their acceptance and consumption of the fortified food. Food fortification is thus generally recommended as a socially acceptable intervention because it requires no behavioral change on the part of the target population other than a continuance of existing food habits. The acceptability of the fortified food should be assessed, however, to ensure that people like the product and that any alterations in organoleptic properties are within acceptable limits.

Another factor that will influence the acceptability of fortified foods is cost. If the cost of fortification is passed on to the consumer in the form of a price increase, this will deter consumers in low income groups from purchasing the fortified product. When fortified foods cost more than unfortified products, then some form of promotion or education is needed to create consumer demand.

Promotion

Commercial marketing is used to create and sustain consumer demand for fortified products in Western countries. Marketing advantage is greatest where competing products are not fortified and where consumers are aware of the benefits of fortification (British Nutrition Foundation 1994). The role of advertising in influencing food behavior in developing countries has been little examined outside concern about the marketing of infant formulae. If marketing techniques are used to create a demand for fortified foods, then legislation is needed to specify labeling criteria and to prevent false health claims. Regulatory issues are discussed further below.

Education

Consumer education should be a component of fortification programs to increase understanding of nutrition and explain the benefits of consuming fortified foods. This would, in turn, sustain and enhance consumer demand for fortified foods (World Bank 1994). Increasing consumer awareness of food safety issues is also important (WHO 1995) and could compensate for the lack of a proper food control system (TNO et al. 1992c).

Food safety

Food safety is an important consumer issue and measures to improve food preparation and handling practices should be part of any fortification program. These safety measures should cover both the microbial quality of foods and the use of non-food-grade chemical additives, both of which are major consumer concerns.

Consumer organizations

Where they exist, local consumer organizations should also be consulted and engaged. They are a growing force in many developing countries, and, despite the tendency of some government agencies to view them as antagonistic pressure groups (Ariffin 1993), they are an important force in developing and enforcing appropriate food legislation. Where they do not exist, consideration should be given to the possibility of assisting in setting them up.

Informal Sector Street Food Vendors and Producers

The very nature of the street food trade -- that it is a complex sector composed of numerous and heterogeneous micro-enterprises, most of which are officially invisible and possibly hostile -- would not appear conducive to the implementation of a fortification program. It is unlikely, however, that the whole sector would have to be involved in a fortification program. Rather, depending upon the food vehicle and fortification strategy chosen, it would be necessary to target only those sub-groups involved in the production and/or sale of the selected vehicle to the intended target group and who thus control the relevant steps in these processes. The level of involvement required from them would depend upon the food vehicle chosen and whether they would be involved in the actual fortification process or in the distribution and retail of fortified products. Further criteria that could be used to select the target group of entrepreneurs could be their location and/or clientele. Vendors, for instance who locate themselves outside schools and sell their wares predominantly to school children, could be an appropriate target group if children are the intended recipients of the fortification program. In Thailand, there is already a government policy that regulates the sale of street foods to children; this requires the school or university to select the vendors who supply foods on the campus (Tinker 1987).

The social organization and socio-economic characteristics of these groups need to be assessed to determine who is likely to be interested in participating; to identify the incentives that are appropriate; and to find the best means to communicate with and organize them. For instance, the Bogor trial interventions found that street food entrepreneurs varied in their accessibility and receptiveness to the interventions tested. The social factors that affected these were various and would obviously need to be investigated in specific contexts, but the Bogor Project reports point to the need to understand the circumstances in which street food entrepreneurs, particularly women,

operate in order to design appropriate interventions. The incentives offered to producers would also need to be appropriate to the needs of street food entrepreneurs in particular contexts, but could include credit facilities, technical assistance, training in business skills, and subsidization.

Although the interventions tested in the Bogor Streetfood Project to improve the nutritional quality of street foods were focused on the improvement of food safety, one of the project's main recommendations was that any intervention needs to be integrated with the support of the street food entrepreneurs themselves and the strengthening of the socio-economic and legal base of the street food trade as a whole; intervention programs should not just comprise a set of privileges for a small number of entrepreneurs (TNO et al. 1992c). This is necessary to gain the interest and participation of the street food traders and also for the sustainability of an intervention program.

Formal Sector Food and Commodity Processors

Formal sector food processing industries in developing countries are diverse and range from small rural cottage industries processing agricultural products to large urban-based companies making highly processed, packaged products, such as crisps, biscuits, and bottled drinks (Weber 1987). Large multinational companies, such as PepsiCo and Nabisco, are an important presence in some countries and developing country markets have been identified as regions for long term expansion, particularly for snack foods (Lang 1991; Lang 1993). The technology used and the production volume of food processors in developing countries vary widely. Again, only the involvement of those engaged in the processing or production of the chosen food vehicle would be needed but, whether large or small scale, some kind of incentive would be required. These could include import and production subsidies, such as reduced tariffs on the fortificant(s) and low-interest loans to purchase fortification equipment, and technical assistance (World Bank 1994).

With regard to commercially processed foods, which offer the fewest potential constraints in processing terms, fortification could be used as a marketing tool as it is in many developed countries (Lang 1992). This could provide a commercial incentive but, as mentioned above, this requires legislative criteria to specify labeling requirements and nutrient claims. Also, if fortification is used to justify a price increase of the final product, then it may place the product beyond the purchasing power of the intended target group. Most profit margins in developing countries derive from volume sales, rather than price margins.

Government and Regulatory Bodies

National governments have a role in creating the appropriate policy and regulatory environment for the implementation and success of a fortification program. There are two

dimensions to this: (1) in relation to the street food trade, and (2) legislative and enforcement issues relating to fortification.

The Street Food Trade

The lack of official recognition of the street economy in many developing countries makes it impossible to regulate or control the street food trade with a view to improving the quality of street foods (Dawson and Canet 1991). It also leaves the vendors unprotected and open to harassment. WHO, FAO, and EPOC all consider the legalization of the street food trade to be an essential precondition to both assisting traders and improving the quality of their products (Tinker 1988; FAO 1989; WHO 1995). In addition, there is great variation in the legislation governing street foods in different countries.

FAO has called for the development of licensing systems for street food operatives, the formulation of appropriate food laws and legislation, and the establishment of inspection systems by the relevant health authorities to ensure that these would be enforced (FAO 1989). In addition, the cost of licensing -- and who will bear it -- needs to be considered. Vendors may resist licensing because for some, their lack of legal status carries the benefits of tax evasion (FAO and Food Basket Foundation International 1991). There is also a danger that over-regulation of street foods may reduce their availability to the urban poor for whom street foods are a nutritionally significant part of the diet.

There is a need for the incorporation of the street food trade into local policy and planning processes, and the improvement of facilities, such as water supply and refuse disposal (Jayasuriya 1994). Resettlement programs have been successful in some countries, such as Singapore, but this may carry disadvantages for some entrepreneurs, such as women who operate from their homes and combine business with domestic activities.

Fortification

It is usually recommended that fortification should be legally required in order to gain industry compliance and to regulate and control the fortification process (World Bank 1994). This, however, requires government legislation, an effective system of enforcement, and comprehensive monitoring procedures to ensure quality control and that the correct levels of fortificant are maintained in the food vehicle. As these measures would be difficult to apply to street foods, alternative ways to gain compliance need to be explored. Also, legal mandates are usually used to enforce universal fortification, which, depending upon the food vehicle, may not be necessary in relation to the fortification of street foods. There have been cases of successful voluntary fortification in both developed and developing countries (Nestel 1993).

Other related legislative issues include the need to prevent the use of non-food grade chemical additives and, if fortification is to be used as part of a marketing and

promotional strategy for the fortified food products, the need to control food labeling and the nature of permissible health claims that can be made for the food. False advertising is an important issue, and most developed countries have strict nutrition labeling regulations which specify what may and may not be stated on food packaging.

Conclusion and Recommendations

Undernutrition in developing countries remains a problem and multi-pronged strategies are needed to address it. The potential of street foods to improve dietary quality has not yet been investigated. Street foods offer two potential strategies for micronutrient fortification: (1) ingredient-based fortification of items used in the preparation of street foods, which have passed through some form of centralized processing; and (2) food-based fortification of centrally processed foods sold "on street." Such a program could either be targeted at specific population groups, such as school children, or universal.

There are many ingredients and commodities that technically can be fortified, such as cereal products, sugar, salt, MSG, and oils. The identification of a single food or ingredient that meets all the conditions of consumption, chemical composition, and processing would require detailed information about how street foods are produced, used, and consumed in any particular context. Potential limitations are the heterogeneity of street foods and those involved in the street food trade; the large number of suppliers likely to be involved in the production of ingredients; the heterogeneity and lack of reliability of delivery systems; microbiological safety; irregular consumption; and cost. Alternatively, as recommended by EPOC, street food vendors could be used as a means of introducing new food products to consumers. Urban populations are becoming increasingly reliant on processed foods, such as snacks, and food-based fortification would avoid many of the potential limitations listed above, but would raise issues with regard to appropriate marketing, food labeling, cost, and the need for market incentives. A final option that may offer a more appropriate and cost-effective means of improving the micronutrient content of street foods is the use of micronutrient-rich foods.

The implementation of any fortification program would require an integrated approach to address the needs of both consumers and street food entrepreneurs. The involvement of groups from different sectors could provide an opportunity to link fortification with other objectives, such as the improvement of food safety, nutrition education, and the development of appropriate and effective food legislation.

Given the lack of information, it is not currently possible to recommend any specific food as suitable for fortification. It is therefore recommended that:

- Further research should be conducted into all aspects of the street food trade, including investigating the socio-economic and organizational aspects of the trade as well the ingredient content, nutrient composition, production, and consumption

patterns of street foods in particular contexts. This research should be focused on countries where the consumption of street foods is already widespread, such as Indonesia.

- Feasibility studies should be conducted to assess the potential for micronutrient fortification of street foods, both ingredient- and food-based, and the possibility of developing foods targeted at particular population groups, such as school children. These should include: evaluation of consumption patterns and the efficacy of fortification in terms of delivering nutritionally significant amounts of micronutrients to the intended consumers; acceptability studies to ensure that any organoleptic changes resulting from fortification will not adversely affect consumption; evaluation of the bioavailability of added nutrients under conditions of actual use and consumption; analysis of delivery systems and whether these are adequate; evaluation of cost-benefit relationships and the effects of price changes on consumption patterns.

- Ways of linking fortification with other nutrition-relevant actions, in particular food safety and nutrition education should be explored. This should include the possibility of forming inter-sectoral linkages, for instance between consumer groups, regulatory bodies, and the food industry to enhance participation in the creation of a safe food delivery system.

- Ways of linking nutrition interventions with support of the trade itself and the development of income-generating programs should be investigated.

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APPENDIX 1

List of Studies on Street Foods

This list is arranged by geographic region and country. It comprises published materials, which are primarily journal articles, and unpublished project reports. The former were identified by comprehensive literature searches of relevant databases (CAB, FSTA, Medline, Human Nutrition SP, Econlit, and Popline). Much of the information on street foods, however, falls into the category of the so-called gray or fugitive literature. This literature is notoriously difficult to identify and so, although all efforts were made to locate all relevant material, inevitably there will be some reports that are not included. Published food safety studies are included.

Africa

FAO regional workshop 1992 held in Accra, Ghana. The report (FAO 1992) includes brief summaries of country papers from Botswana, Cameroon, Gambia, Ghana, Kenya, Lesotho, Malawi, Nigeria, Sierra Leone, Tanzania, Uganda, and Zambia. Available from FAO.

Benin: Food safety study (de Giusti et al. 1993).

Egypt: EPOC study conducted in Minia (Loza 1985); also a food safety study (El-Sherbeeny et al. 1985).

Kenya: Study of street foods and vendor characteristics in Nairobi, which includes data on food preparation practices and microbial quality and some information on the macronutrient content of selected foods (Korir 1994).

Mali: Study of school childrens' consumption of street foods (Chauliac et al. 1994).

Nigeria: EPOC study conducted in Ile-Ife (Kujore and Chase 1985; Pearce 1984); also three FAO studies, two conducted in collaboration with Food Basket Foundation International, which were: a training program for women in Ibadan (FAO and Food Basket Foundation International, 1990); a study of the socio-economic characteristics of vendors and consumers in Ibadan, Lagos, and Kaduna (FAO and Food Basket Foundation International 1991); and, the third conducted in collaboration with the University of Ibadan, also of the characteristics of vendors and consumers in Ibadan (Akinyele 1987).

Senegal: EPOC study conducted in Ziguinchor (Posner 1983).

Tanzania: Food safety studies conducted by the Tanzania Food and Nutrition Commission.

Uganda: FAO study on street foods in Kampala with a focus on socio-economic and food safety aspects (Nasinyama 1992).

Asia

Bangladesh: EPOC study conducted in Manikganj, Bangladesh (Owens and Hussain 1984); a project to improve processing methods of traditional snack foods was also conducted in Manikganj (Edmister and Kuipers 1989).

China: FAO and Institute of Food Safety Control, Ministry of Public Health collaborative pilot study conducted to improve food safety in five cities (FAO and Institute of Food Safety 1993); food safety study (Liang and Yuan 1991).

India: IDRC-funded study in Pune (Kulkarni 1992; Bapat 1992) with a focus on the socio-economic environment in which street food vendors operate, but also microbiological testing of some foods; FAO-supported study in Calcutta with a focus on food safety (Chakravarty 1994).

Indonesia: The Bogor Streetfood Project, which includes studies of the nutritional quality and consumption of street foods, studies of the social organization of the trade itself, and pilot interventions (Hartog 1992; IPB et al. 1990; TNO et al. 1992a; TNO et al. 1992b; TNO et al. 1992c), funded jointly by Dutch and Indonesian governments; EPOC study also conducted in Bogor (Chapman 1984).

Malaysia: Study of the nutrient content of both commercial and traditional snack foods (Tee et al. 1989).

Nepal: FAO-supported study on food handling and preparation practices of street food vendors in Nepal, includes some information on vendor characteristics and consumption patterns (Joshi et al. 1988); also WHO-supported study of the safety of street foods using the HACCP approach (Gongal et al. 1993).

Pakistan: Food safety studies of various foods products using the HACCP approach (Bryan and Teufel 1993; Bryan et al. 1992a; Bryan et al. 1992b; Bryan et al. 1992c).

Philippines: EPOC study conducted in Iloilo City (Barth 1985; Barth 1983); also a study conducted by the Food and Nutrition Research Institute, Manila.

Thailand: EPOC study conducted in Chonburi (Szanton and Sirisambhand 1986); food safety studies (Malai et al. 1993; Nednapis 1994).

South and Central America

FAO and PAHO regional workshops.

Mexico: Study of preparation and sale outside the home in Mexico City, which includes some information on street foods and the informal sector and the complex organization of the food supply system, partly funded by IDRC (Bueno 1988); food safety study (Departamento de Bioquimica 1986).

Caribbean

Dominican Republic: Food safety study (Bryan et al. 1988).

Haiti: Study of street foods and their consumption by school children (Webb and Hyatt 1988).

Jamaica: IDRC-funded study of the socio-economic aspects and organization of the street food trade in Kingston, including the role of women (Powell et al. 1990).

Trinidad and Tobago: Food safety study of a popular street food, doubles (Wiseman 1995).

APPENDIX 2

Regional Code of Practice for the Preparation and Sale of Street Vended Food Alinorm 95/36 for Latin America and the Caribbean

SECTION I - INTRODUCTION

This Code contains a series of requirements and practices to be observed in the preparation and sale in the street of food and beverages for direct consumption.

This standard shall govern all individual and legal entities involved in the preparation and/or sale of food and beverages in the public street and shall apply to places where they are prepared, points where they are sold and means of transport used. Its purpose is to ensure a food or beverage product that is safe and fit for consumption, and thus protect the health of the persons who use this type of food service.

SECTION 2 - DEFINITIONS

For the purposes of this Code, the following terms shall have the following meanings:

- *Running water:* Water coming out of a tap.
- *Waste water:* Water from domestic and industrial drains.
- *Street foods:* Ready-to-eat foods and beverages prepared and/or sold by vendors especially in streets and other similar public places.[1]
- *Environment:* That which surrounds the food.
- *Drinking water:* That which has been treated and is contaminant-free and fit for human consumption.
- *Food and beverages for direct consumption:* Any type of hot or cold food or beverage that requires some degree of preparation before being consumed.
- *Coproculture:* The sowing of excrement on a culture medium to identify the microorganisms it contains.
- *To taste:* To test the flavor of a preparation.
- *Sputum:* Naso-pharyngeal secretion which is ejected by spitting.
- *Enteric:* Pertaining or relating to the intestines.
- *Germs:* Microbes
- *Hermetic:* Complete and impenetrable (closure).
- *Ingredients:* Components of a mixture.
- *Impermeable:* Not allowing the passage of water.
- *Informal:* Not official or authorized.
- *Input:* Element needed to obtain a product.
- *Organoleptic:* Assessment made through the sense organs (sight, smell, touch, taste).
- *Perishable:* Easily spoiling or decomposing.

[1] Street foods: the term approved at the Regional Workshop on Street-Vended Foods held in Yogyakart, Indonesia, in November 1986.

- *Sales point:* Any fixed or mobile structure intended for the sale of food or drink for direct consumption in the street.
- *Pests:* Undesirable animals.
- *Crockery:* All glasses, plates and dishes used in serving meals.

SECTION 3 - REQUIREMENTS FOR INPUTS AND INGREDIENTS

3.1 Purchase of Inputs and Ingredients

3.1.1 Purchase inputs and ingredients sold in clean places and stored on shelves, in boxes or baskets, as such inputs and ingredients will not be contaminated. Never buy products that are placed directly on the ground.

3.1.2 Purchase meat from approved slaughterhouses; reject products of clandestine slaughter, as clandestine meat has not been inspected and may come from diseased animals.

3.1.3 Purchase packaged inputs and ingredients that bear a guarantee or manufacturers' brand name (not unlabelled, unpackaged food of informal origin) so that should any illness result from their consumption, the manufacturer or producer may be easily located to clarify the question of responsibility and avoid new outbreaks.

3.1.4 Purchase products whose sensory properties (smell, taste, colour, texture, etc.) are those of fresh, not spoiled food, as this is a sure way of purchasing the best quality food.

3.2 Transport, Reception and Storage of Inputs and Ingredients

3.2.1 Products used in the preparation of meals shall be transported in such a way as to avoid their being spoilt by heat or the length of the journey, or contaminated by undesirable substance or products (contaminants) that may be transported together and accidentally become mixed with them, causing poisoning.

3.2.2 Inputs and ingredients must be received in a clean and protected place; meat, offal and fish shall be placed on trays, and bulk commodities in clean containers.

3.2.3 Non-perishable food which is not used immediately should be kept covered, in closed containers, etc.; this will prevent contact with pests (flies, cockroaches, rodents) which may contaminate it.

3.2.4 Perishable food (milk, fish, meat and shellfish) which is not going to be prepared immediately, should be kept refrigerated; this will prevent the food from spoiling and becoming dangerous to eat.

3.2.5 Keep receptacles containing food clearly labelled and in separarate areas from those containing soap and toxic or poisonous substances; correct labelling may prevent fatal accidents.

SECTION 4 - REQUIREMENTS FOR THE PLACE OR AREA OF PREPARATION

4.1 Place of Preparation: Food shall be prepared in a place set aside exclusively for that purpose; the place of preparation shall be sufficiently lit, kept clean at all times, and shall be far from any source of contamination (rubbish, waste water, animals). The reason for this is that food is most likely to become contaminated during preparation, the danger being all the more serious if the food is going to be eaten raw or only slightly cooked.

4.2 Final Place of Preparation: Similarly, if food preparation is completed in sales points on the public street, the area must be clean, protected from the sun and wind, separate from and not accessible to the public, for the same reasons as above (4. 1).

4.3 Sanitary Facilities: The places where food is prepared must have a drinking water supply, waste water disposal facilities and bins for rubbish and refuse; these are the basic sanitary arrangements needed to ensure that food is kept free of contamination.

4.3.1 When food is prepared at points on the public street, care must also be taken to ensure that good quality water and waste water and rubbish disposal facilities are available.

4.3.2 Water at sales points may be kept in duly protected stainless containers of at least 20 litres capacity. Rubbish and refuse bins must be made of impermeable material, easy to clean and have a plastic bag inside in order to facilitate handling of the rubbish.

4.4 Working Surfaces: Working or preparation surfaces must be made of hygienic, impermeable material that is easy to clean and in good condition; they should be at least 60 to 70 cm from the ground.

4.5 Utensils: Saucepans, other cooking utensils and crockery must be clean and in good condition. Unsuitable materials such as copper, cadmium, lead and other toxic materials should not be used, BECAUSE these metals react easily with food, forming toxic compounds, particularly if the food is acid.

SECTION 5 - REQUIREMENTS FOR PRELIMINARY PREPARATION

5.1 Handling Utensils

5.1.1 Surfaces that are in contact with food shall be scrubbed with soap, water and

detergent after every operation. This prevents recontamination of food if the product previously in contact with the surfaces was contaminated. Scrubbing removes germs and scraps of food from the surfaces.

5.1.2 Wash all utensils with soap and water before use; this lowers the risk of contaminating food with dirty utensils.

5.1.3 Keep fuel or any inflammable product in closed, labelled containers, far from food and cookers.

5.1.4 The mixing of ingredients before cooking or serving should be done in receptacles specially intended for that purpose.

Do not use others which may have previously contained toxic products (e.g. insecticide containers, paint tins, motor oil cans, etc.) as they may still be impregnated with residues of the toxic substance which could pass into the food, and also, because the material they are made of is not suitable for holding food.

5.2 Hygienic Practices

5.2.1 Wash hands with soap and water before handling food or when changing from one activity to another. A container should be kept exclusively for washing hands; dirty hands are the main source of contamination and carriers of most food-bome diseases.

5.2.2 Wash greens and other vegetables in plenty of water, taking special care with those to be eaten raw; they might have been irrigated with waste water, in which case they would be highly contaminated, and eating them would constitute a health risk.

5.2.3 Wash all food, including meat, before preparing it in order to reduce the risks of contamination.

5.2.4 Food should be washed with running, drinking water, because as it flows over the food, it washes away some of the contaminants.

5.2.5 Clothes should be protected with an overall or apron and hair covered with a cap throughout food handling, as this prevents clothes from touching the food or hair from falling into dishes.

5.2.6 Do not wear rings or bracelets while handling food.

5.2.7 Food should not be handled by persons with cuts or sores, as these are a source of germs that can contaminate food on contact.

SECTION 6 - REQUIREMENTS FOR FINAL PREPARATION

6.1 Cooking and Handling

6.1.1 Cook the food sufficiently (whether boiling or cooking directly over a fire), as heat destroys many contaminants, especially germs and parasite cysts.

6.1.2 If the food is not served immediately it should be kept in a cool, well ventilated place or, better still, refrigerated, but never outdoors or exposed to the sun; germs proliferate easily in food that is not kept cool.

6.1.3 As regards reheating food, only the portion to be served should be reheated and not more than once, because reheating insufficiently or more than once causes germs to multiply to the point where the food becomes dangerous.

6.1.4 Cooking utensils should be of suitable, hygienic material and receptacles should be heat-resistant and used only for food preparation.

6.2 Hygienic Practices

6.2.1 Always wash the utensil used to taste food before putting it back into the pot, as food can become contaminated with germs from the cook's mouth.

6.2.2 Avoid sneezing or coughing over the food, particularly when it is ready to be served; coughs and sneezes contain germs which can contaminate food.

6.2.3 Wash hands with soap and water before starting preparation and after every change of activity during food handling.

6.2.4 Salads should be prepared with the aid of utensils, never with the hands which are the main vehicle of contamination.

SECTION 7 - REQUIREMENTS FOR THE TRANSPORT OF PREPARED FOOD

7.1 When food is transported to the place of sale, it should be in hermetically sealed and protected containers in order to avoid contact with dirty surfaces; if the vehicle is not suitable for transporting foodstuffs, maximum precautions should be taken to protect the food.

7.2 The place where food is prepared should be as near as possible to the place where it is sold, so as to avoid deterioration in transport over long distances.

SECTION 8 - REQUIREMENTS FOR MARKETING

8.1 The Sales Point and its Surroundings

8.1.1 Sales points (kiosks, barrows, mobile stalls, etc.) shall be built of solid, resistant material, kept clean and in good condition, and in a clean place when not in use. They should not be used for any other purpose.

8.1.2 They should be stationed in authorized areas where they do not interfere with vehicular traffic and/or obstruct pedestrians.

8.1.3 The sales points (including working surfaces, awnings, tables, benches and boxes, cupboards, glass cases, etc.) should always be kept clean and tidy, as they should not only look nice, but also be suitable for selling food.

8.1.4 Never keep in the sales point articles that are not needed for the handling and marketing of food, such as clothes, blankets, footwear and baby's clothes, as these objects are further sources of food contamination.

8.1.5 Sales points should not be used as permanent or temporary dwellings, but exclusively for the handling and marketing of food, in order to reduce the risk of food contamination.

8.1.6 The surroundings of the sales points should be kept clean and litter-free. This will make the site more attractive to consumers and prevent further pollution of the environment and contamination of the food by the environment.

8.1.7 No animals should be allowed in or near the sales point as they could contaminate the food and transmit diseases.

8.2 Protection and Serving of Food

8.2.1 The food and beverages displayed for sale must be protected in glass cases, covered with bell- shaped wire-netting or plastic covers (minimum height 60 to 70 cm).

8.2.2 Disposable plates, covers and glasses should be used to serve food and beverages. If this is not possible, plates, covers and glasses used should be clean and in good condition.

8.2.3 If the sales point is a vehicle, the driving compartment shall be duly separated from the area where food is handled.

8.2.4 Prepared food which is not sold during the day may not be used the following day.

8.2.5 Take-away food shall be wrapped in unused paper and/or plastic. The use of printed plastic or paper is forbidden, particularly if it comes into direct contact with the food.

8.2.6 Only final preparation, heating and serving of food is allowed in the sales point.

8.2.7 The utensils in which the food is displayed for sale must be kept clean, covered and protected, as they easily become contaminated if left dirty or unprotected.

8.2.8 Wash utensils with detergent and running, drinking water, and categorically reject the use of buckets or other receptacles containing water that is not thrown away immediately after use; if the same water is used twice it may lead to contamination and recontamination of the utensils washed in it.

8.2.9 Serve the food in easily washable utensils, as this will make it more difficult for scraps of food to remain on them and germs to develop.

8.2.10 Serve the food using serving utensils in order to avoid touching the food or the surface with which it will be in contact.

8.2.11 Do not handle money and food at the same time, as money is a contaminating element. The person handling food should not have any contact with money, but if this is unavoidable, he/she should wash his/her hands before handling food again.

8.3 Requirements for the Vendor/Handler

8.3.1 Any food vendor/handier should wear appropriate clothing, consisting of at least an apron and cap for men and a haimet or headscarf for women, which should always be clean and in good condition, and preferably white or pale in colour.

8.3.2 Every handler/vendor should receive training in hygienic food handling, because training gives the handler/vendor the knowledge needed to provide a food product for direct consumption under adequately hygienic conditions.

8.3.3 Handlers/vendors should observe elementary hygienic practices: short hair, clean, short fingernails, clean hands, no coughing or sneezing over the food, no handling of food with cuts or skin infections, no smoking during the preparing and serving of food, because hygienic habits enable consumers to be provided with food prepared and served in proper hygienic conditions.

8.4 Handling and Disposal of Wastes

8.4.1 Rubbish bins must be kept away from where food is handled and always be covered with lids, as this will prevent them from attracting pests.

8.4.2 Solid (sweepings, etc.) and liquid (washing water) wastes should always be kept separate, as this makes their removal easier and reduces the risk of contamination.

8.4.3 The separate wastes shall be disposed of as follows:
- cleaning wastes shall be put into a receptacle reserved for this purpose for later removal by the garbage collection service; and
- liquid wastes will go down the nearest drain.

This will prevent the drains being blocked by solid wastes and thus becoming a hotbed for contamination and pest proliferation.

8.5 Vector Control

- The area shall be kept clean and tidy in order to prevent the proliferation of insects and rodents.
- The area shall be fumigated from time to time (methods approved by the health authorities), as this will help prevent disease.
- Waste should be properly managed, i.e. rubbish should be placed in receptacles fitted with lids and emptied regularly.
- Left-over food should not be kept in the sales points.

APPENDIX 3

Codex Advisory Lists of Mineral Salts and Vitamin Compounds for Use in Foods for Infants and Children

In the Codex system, food fortification falls within the jurisdiction of the Codex Committee on Nutrition and Foods for Special Dietary Uses (also sometimes known as the Bonn Committee). The Codex General Principles for the Addition of Essential Nutrients to Foods (CAC/GL 09-1987) are contained with Volume 4 of Codex Alimentarius (1994). This also contains the Advisory Lists of Mineral Salts and Vitamin Compounds for Use in Foods for Infants and Children (CAC/GL 10-1979), which were adopted by Codex in 1979 and subsequently amended in 1983 and 1991.

Advisory List of Mineral Salts for Use in Foods for Infants and Children

Salts	Purity Requirements	Use in Foods for Infants and Children
1. Source of Calcium (Ca)		
1.1 Calcium carbonate	FCC, FAO/WHO	Milk substitute formulae; infant cereals
1.2 Calcium chloride	FCC, FAO/WHO	Milk-based and milk substitute formulae
1.3 Calcium citrate	FCC, FAO/WHO	Milk-based, milk substitute, protein hydrolysate and meat-based formulae
1.4 Calcium gluconate	FCC, FAO/WHO	Protein hydrolysate formulae
1.5 Calcium glycerophosphate	FCC	
1.6 Calcium lactate	FCC, FAO/WHO	Electrolyte mixture supplement
1.7 Calcium phosphate, monobasic	FCC, FAO/WHO	Milk substitute and low sodium formulae
1.8 Calcium phosphate, dibasic	FCC	Milk substitute and protein hydrolysate formulae
1.9 Calcium phosphate, tribasic	FCC, FAO/WHO	Milk substitute, protein hydrolysate and premature formulae; infants cereals
1.10 Calcium oxide	FCC, FAO/WHO	Protein supplement formulae
1.11 Calcium sulphate	FCC, FAO/WHO	Infant cereals

Salts	Purity Requirements	Use in Foods for Infants and Children
2. Source of Phosphorus (P)		
2.1 Calcium phosphate, monobasic	FCC, FAO/WHO	Milk substitute and low sodium formulae
2.2 Calcium phosphate, dibasic	FCC	Milk substitute and protein hydrolysate formulae
2.3 Calcium phosphate, tribasic	FCC, FAO/WHO	Milk substitute, protein hydrolysate and premature formulae; infant cereals
2.4 Magnesium phosphate, dibasic	FCC	Milk substitute and lactose-free formulae
2.5 Magnesium phosphate, tribasic	FCC, FAO/WHO	
2.6 Potassium phosphate, monobasic	FCC, FAO/WHO	Protein hydrolysate formulae
2.7 Potassium phosphate, dibasic	FCC, FAO/WHO	Milk-based, milk substitute and protein hydrolysate formulae
2.8 Sodium phosphate, dibasic	FCC, FAO/WHO	Electrolyte mixture supplement
2.9 Phosphoric acid	FCC, FAO/WHO	All infant and follow-up formulae; cereal-based foods for infants and children
3. Source of Chloride (Cl)		
3.1 Calcium chloride	FCC, FAO/WHO	Milk-based, milk substitute and protein supplement formulae; electrolyte mixture supplement
3.2 Choline chloride	FCC, FAO/WHO	Milk-based, milk substitute and protein hydrolysate formulae
3.3 Magnesium chloride	FCC, FAO/WHO	Milk-based, milk substitute and lactose-free formulae
3.4 Manganese chloride	FCC	Milk-based formulae
3.5 Potassium chloride	FCC, FAO/WHO	
3.6 Sodium chloride	FCC, FAO/WHO	Milk substitute formulae, baby foods, and electrolyte mixture supplement
3.7 Sodium chloride, iodized	FCC	Milk substitute formulae
3.8 Hydrochloric acid	FCC, FAO/WHO	All infant and follow-up formulae; cereal-based foods for infants and children

Salts	Purity Requirements	Use in Foods for Infants and Children
4. Iron (Fe)		
4.1 Ferrous carbonate stabilized	MI	
4.2 Ferrous citrate	MI	Milk and soy-based liquid infant formulae
4.3 Ferrous fumarate	FCC	Vitamins, iron supplement
4.4 Ferrous gluconate	FCC, FAO/WHO	
4.5 Ferrous lactate	MI	Milk and soy-based liquid infant formulae
4.6 Ferrous succinate	MI	
4.7 Ferrous sulphate	FCC	Milk-based, milk substitute and protein hydrolysate formulae
4.8 Ferric ammonium citrate	FAO/WHO	
4.9 Ferric citrate	MI	Milk and soy-based liquid infant formulae, not allowed in powdered formulae, cereals or canned baby foods
4.10 Ferric gluconate	MI	Milk and soy-based liquid infant formulae, not allowed in powdered formulae, cereals or canned baby foods
4.11 Sodium ferric pyrophosphate	MI	
4.12 Hydrogen reduced iron	FCC	Infant cereals; protein supplement formulae
4.13 Electrolytic iron	FCC	Infant cereals
4.14 Carbonyl iron	MI	
4.15 Ferric pyrophosphate	FCC	Milk-based formulae
5. Source of Magnesium (Mg)		
5.1 Magnesium carbonate	FCC, FAO/WHO	Baked products
5.2 Magnesium chloride	FCC, FAO/WHO	Milk-based, milk substitute and lactose-free formulae
5.3 Magnesium oxide	FCC, FAO/WHO	Milk substitute, protein hydrolysate and premature formulae
5.4 Magnesium phosphate, dibasic	FCC	Milk substitute, lactose free formulae

Salts	Purity Requirements	Use in Foods for Infants and Children
5.5 Magnesium phosphate, dibasic	FCC, FAO/WHO	
5.6 Magnesium sulphate	FCC	Electrolyte mixture supplement
6. Source of Sodium (Na)		
6.1 Sodium bicarbonate	FCC, FAO/WHO	Milk-based formulae, glazed products
6.2 Sodium carbonate	FCC, FAO/WHO	Protein hydrolysate formulae
6.3 Sodium chloride	FCC, FAO/WHO	Milk substitute formulae, baby foods, electrolyte mixture supplement
6.4 Sodium chloride, iodized	FCC	Milk substitute formulae
6.5 Sodium citrate	FCC, FAO/WHO	Milk-based, milk substitute and protein hydrolysate formulae, electrolyte mixture supplement
6.6 Sodium gluconate	FCC	
6.7 Sodium lactate	FAO/WHO	
6.8 Sodium phosphate, monobasic	FCC, FAO/WHO	Milk substitute formulae
6.9 Sodium phosphate, dibasic	FCC, FAO/WHO	Electrolyte mixture supplement
6.10 Sodium phosphate, tribasic	FCC, FAO/WHO	
6.11 Sodium sulphate	FCC	
6.12 Sodium tartrate	FCC, FAO/WHO	
7. Source of Potassium (K)		
7.1 Potassium bicarbonate	FCC, FAO/WHO	
7.2 Potassium carbonate	FCC, FAO/WHO	
7.3 Potassium chloride	FCC, FAO/WHO	
7.4 Potassium citrate	FCC, FAO/WHO	
7.5 Potassium glycerophosphate	FCC	
7.6 Potassium gluconate	MI	
7.7 Potassium phosphate, monobasic	FCC, FAO/WHO	Protein hydrolysate formulae
7.8 Potassium phosphate, dibasic	FCC, FAO/WHO	Milk-based, milk substitute and protein hydrolysate formulae

Salts	Purity Requirements	Use in Foods for Infants and Children
8. Source of Copper (Cu)		
8.1 Copper gluconate	FCC	
8.2 Cupric carbonate	MI	Baked products, protein supplement formulae
8.3 Cupric citrate	MI	Milk-based, protein hydrolysate and meat-based formulae
8.4 Cupric sulphate	MI	Milk-based, protein hydrolysate and meat-based formulae
9. Source of Iodine (I)		
9.1 Potassium iodide	FCC	Milk-based, milk substitute, meat-based formulae
9.2 Sodium iodide	FCC	Milk-based, milk substitute and protein hydrolysate formulae
9.3 Potassium iodate	FCC, FAO/WHO	
10. Source of Zinc (Z)		
10.1 Zinc acetate	MI	
10.2 Zinc chloride	MI	
10.3 Zinc oxide	MI	Protein hydrolysate formulae
10.4 Zinc sulphate	FCC	Milk-based, milk substitute and protein hydrolysate formulae
11. Source of Manganese (Mn)		
11.1 Manganese carbonate	MI	
11.2 Manganese chloride	FCC	Milk-based formulae
11.3 Manganese citrate	MI	
11.4 Manganese sulphate	FCC	Milk-based, milk substitute and protein hydrolysate formulae

Abbreviations:

FAO/WHO	General Principles for the Use of Food Additives, Codex Alimentarius Volume 1.
FCC	Food Chemicals Codex
MI	Merck Index

Advisory List of Vitamin Compounds for Use in Foods for Infants and Children

Vitamin	Vitamin Form	Purity Requirements
1. Vitamin A	Retinyl acetate Retinyl palmitate Retinyl propionate	USP, BP, Ph.Eur., FCC USP, BP, Ph.Eur., FCC USP, BP, Ph.Eur., FCC
2. Provitamin A	Beta-carotene	FAO/WHO, FCC
3. Vitamin D 3.1 Vitamin D_2 3.2 Vitamin D_3	 Ergocalciferol Cholecalciferol Cholecalciferol -cholesterol	 USP, BP, Ph.Eur., FCC USP, FCC DAB
4. Vitamin E	d-alpha-tocopherol dl-alpha-tocopherol d-alpha-tocopheryl acetate dl-alpha-tocopheryl acetate d-alpha-tocopheryl succinate dl-alpha-tocopheryl succinate	NF, FAO/WHO NF, FAO/WHO, FCC NF, FCC NF, FCC FCC NF
5. Thiamin (Vitamin B_1)	Thiamin chloride hydrochloride Thiamin mononitrate	USP, BP, Ph.Eur., FCC USP, FCC
6. Riboflavin (Vitamin B_2)	Riboflavin Riboflavin 5'-phosphate sodium	USP, BP, Ph.Eur., FAO/WHO, FCC BPC, FCC
7. Niacin	Nicotinamide Nicotinic acid	USP, BP, Ph.Eur., FCC NF, BP, Ph.Eur., FCC
8. Vitamin B_6	Pyridoxine hydrochloride	USP, BP, Ph.Eur., FCC
9. Biotin (Vitamin H)	d-biotin	FCC
10. Folacin	Folic acid	USP, BP
11. Pantothenic acid	Calcium pantothenate Panthenol	USP, Ph.Eur., FCC FCC
12. Vitamin B_{12}	Cyanocobalamin Hydroxocobalamin	USP, BP, Ph.Eur. NF, BP
13. Vitamin K_1	Phytylmenaquinone	USP, BP
14. Vitamin C	Ascorbic acid Sodium ascorbate Calcium ascorbate Ascorbyl-6-palmitate	USP, BP, Ph.Eur., FAO/WHO, FCC USP, FAO/WHO, FCC FCC NF, FAO/WHO, FCC
15. Choline	Choline bitartrate Choline chloride	DAB, FCC FAO/WHO, DAB, FCC
16. Inositol		FCC

Abbreviations:

BP	British Pharmacopoeia, including addenda
BPC	British Pharmaceutical Codex
DAB	Deutsches Arzneibuch 7
FAO/WHO	General Principles for the Use of Food Additives, Codex Alimentarius Volume 1
FCC	Food Chemicals Codex
NF	United States National Formulary
Ph.Eur.	European Pharmacopoeia
USP	United States Pharmacopoeia